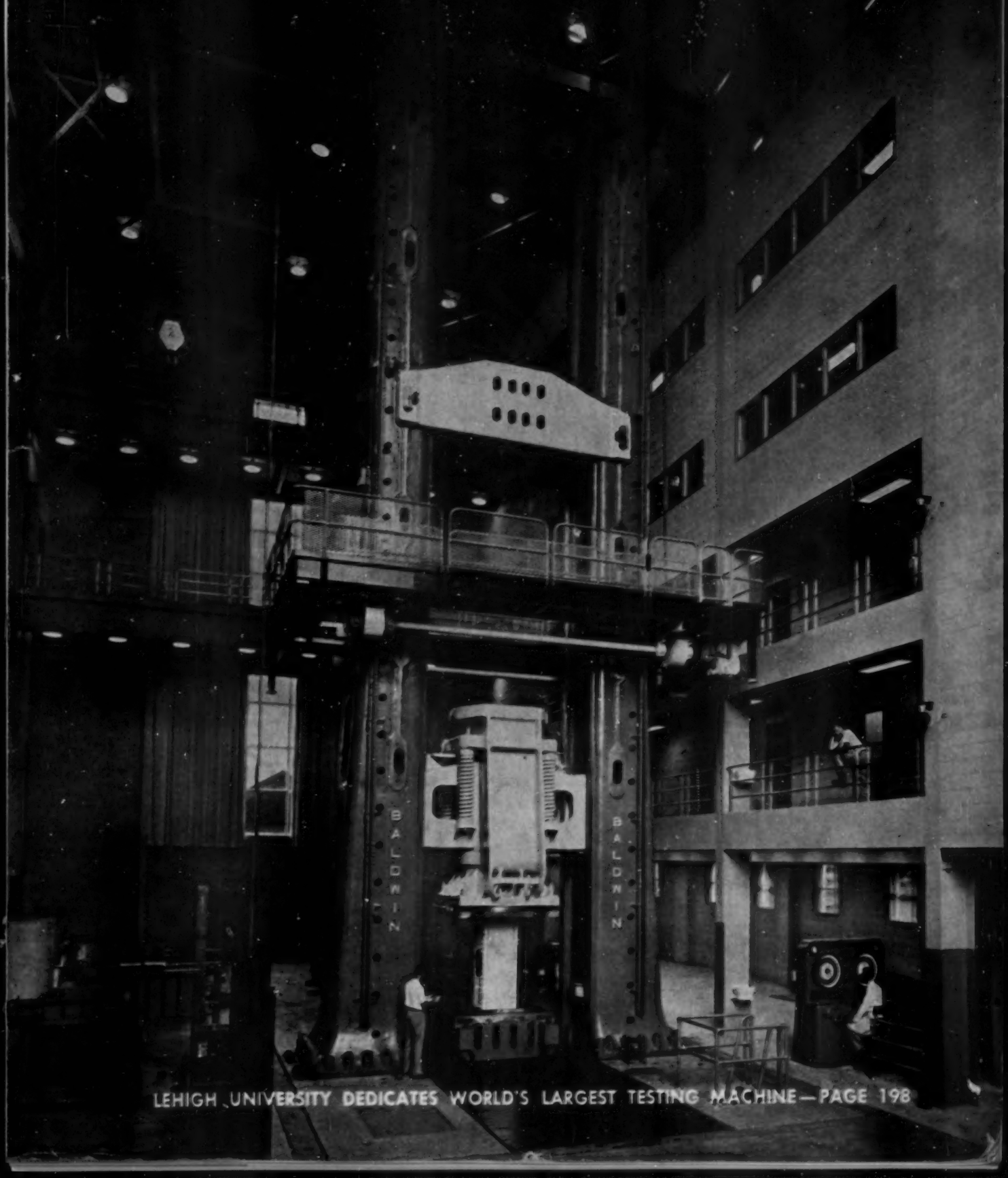
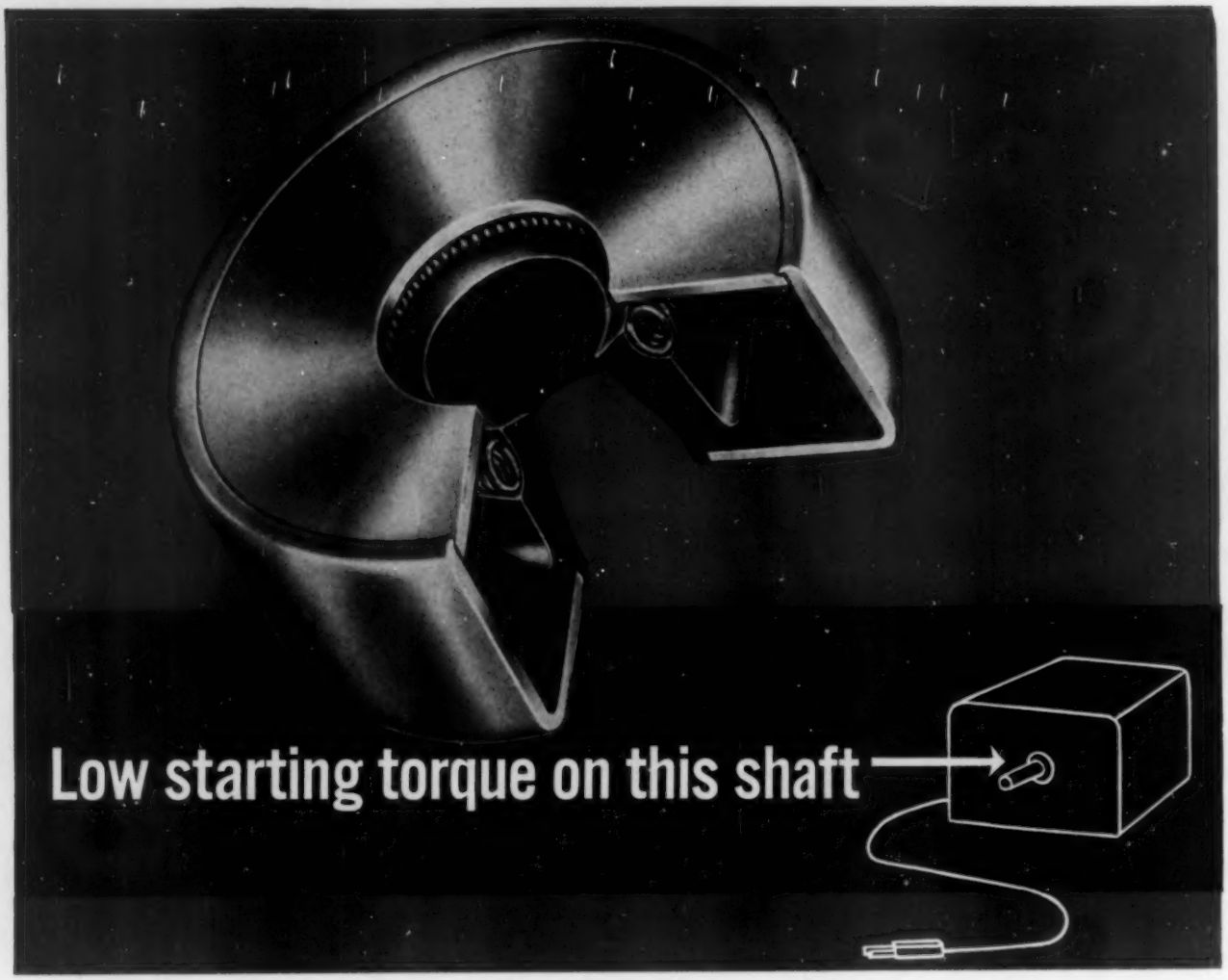
Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

NOVEMBER 1955



LEHIGH UNIVERSITY DEDICATES WORLD'S LARGEST TESTING MACHINE—PAGE 198



AND IT'S C/R SEALED OIL AND WATER-TIGHT FOR LIFE!

You can't put the squeeze on this pump shaft. It's powered by a shaded pole electric motor rated at 1/150 h.p. The unit is oil-filled and hermetically sealed—used to pump water from evaporative-type air conditioners. C/R was asked to supply a seal that would retain the lubricant for life, and exclude water, but give minimum friction to avoid starting difficulty at low voltage. A C/R Oil Seal with a special Sirvene element was developed. It works beautifully. It seals efficiently at pressures up to 35 psi . . . and the breakaway torque is negligible. Applications like this are a specialty with Chicago Rawhide. For over thirty years C/R engineers have been providing equally successful solutions for tough sealing problems . . . and they will welcome the opportunity to help you with yours. For basic information let us send you a copy of "C/R Perfect Oil Seals."

C/R

PERFECT
Oil Seals

More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device.

CHICAGO RAWHIDE MANUFACTURING COMPANY

1301 Elston Avenue OIL SEAL DIVISION **Chicago 22, Illinois**

IN CANADA: SUPER OIL SEAL MFG. CO., LTD., HAMILTON, ONTARIO

Other **C/R** *products*

SIRVENE: (Synthetic rubber) diaphragms, boots, gaskets and similar parts for critical operating conditions • CONPOR: Controlled porosity mechanical leather packings and other sealing products • SIRVIS: Mechanical leather boots, gaskets, packings and related products.

Ross

FOUR WAY REMOTE CONTROLLED MASTER VALVE

- **May Be Removed without Disturbing Piping**
- **For Air and Low Pressure Fluid Service**
- **Working Parts Interchangeable with Ross 700 Series Base Mounted Valves**
- **Poppet Type for Extra Economy**

Write for Engineering Data No. 5411

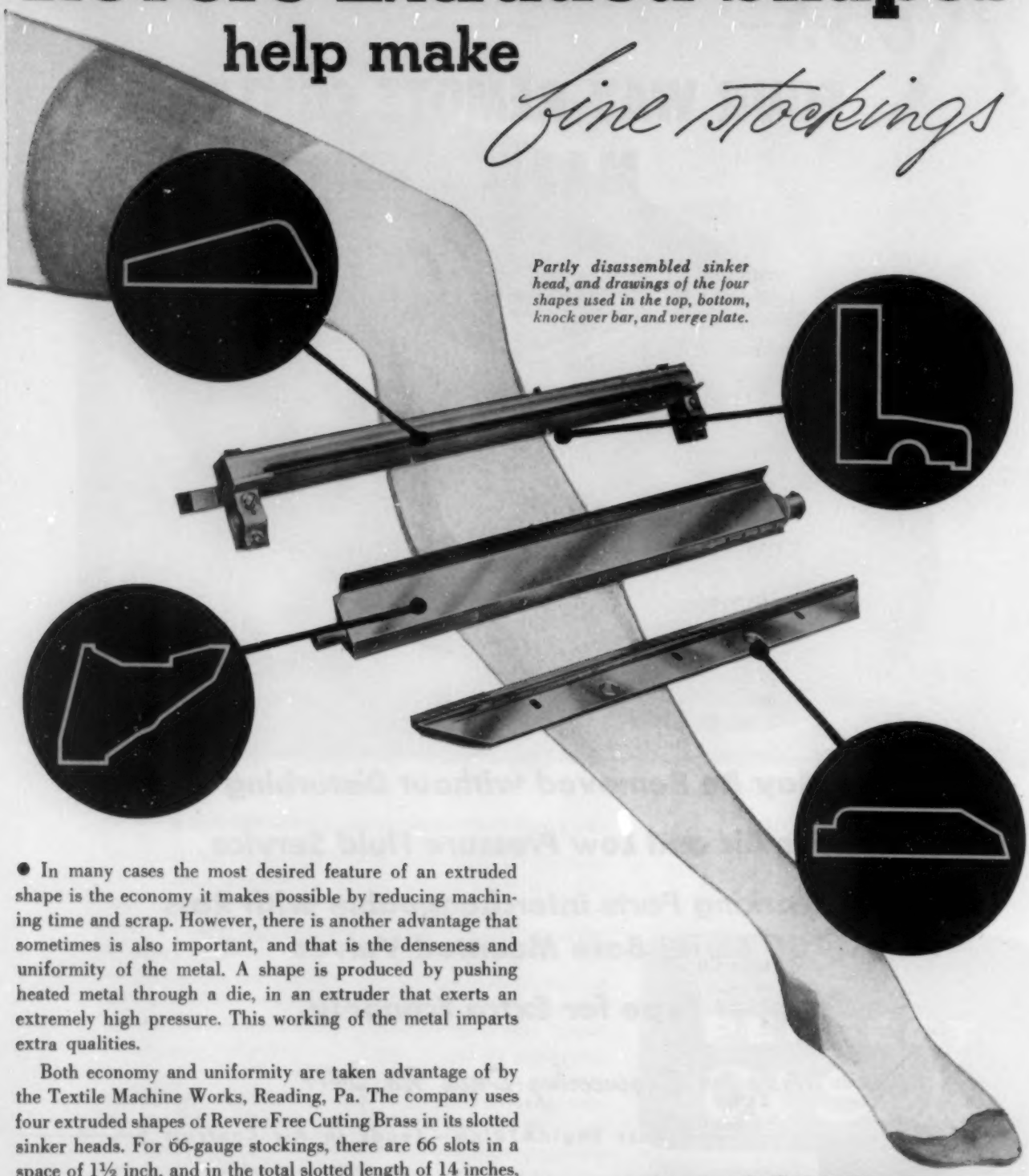
{ Ross EnginAIRing — Leads in Air Controls }

Ross OPERATING VALVE CONTROL COMPANY

114 E. GOLDEN GATE AVENUE • DETROIT 3 • MICHIGAN

Revere Extruded Shapes

help make *fine stockings*



Partly disassembled sinker head, and drawings of the four shapes used in the top, bottom, knock over bar, and verge plate.

● In many cases the most desired feature of an extruded shape is the economy it makes possible by reducing machining time and scrap. However, there is another advantage that sometimes is also important, and that is the denseness and uniformity of the metal. A shape is produced by pushing heated metal through a die, in an extruder that exerts an extremely high pressure. This working of the metal imparts extra qualities.

Both economy and uniformity are taken advantage of by the Textile Machine Works, Reading, Pa. The company uses four extruded shapes of Revere Free Cutting Brass in its slotted sinker heads. For 66-gauge stockings, there are 66 slots in a space of 1½ inch, and in the total slotted length of 14 inches, the tolerance is less than .001 inch. In order to achieve this accuracy, and be assured of straightness and flatness, Textile specifies shapes of extreme uniformity.

Perhaps your requirements are not quite so high as Textile's. Or perhaps they are higher. In either case, we shall be glad to explain how Revere Extruded Shapes can save you money, and at the same time help you maintain the highest quality standards. See the nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere.

Product Engineering

NOVEMBER 1955 Vol. 26 No. 12

The McGraw-Hill Magazine of Design Engineering

Selected Designs of Machine Elements 129

Highlights of the Machine Tool Show held in Chicago from September 6 through 17. A photographic report of design details selected by your Editors as representative to current trends in machine construction, surface protection, power transmission and control, hydraulics and pneumatics, mechanisms, bearings and lubrication.

Preventing Fires from Electrical Causes ..... H. A. Strickland, Jr. 145

Eight ways of reducing operating temperatures in industrial machines and appliances requiring a motor, resistance heater, or other electrical source of heat.

Measuring Performance of Hydraulic Machines ..... H. Stern 150

How to determine input and output power and efficiency from temperature and pressure measurements of hydraulic fluid; methods for measuring rapidly changing temperature.

Product Designs 156

Hydraulically driven thread miller; Dual lubricators on knitting machine; Dial controlled stitching; Cargo carrier for difficult terrain; Amplifier packaged for humidity resistance.

Designing Snap-Action Toggles ..... Erwin F. C. Schulze 168

Formulas and design charts for determining toggle dimensions to obtain maximum snap action.

Kralastics—A New Thermoplastic Material ..... E. J. Trunk 171

New blend of copolymers produce a series of thermoplastic gum materials combining high strength, stiffness and toughness, and resistance to heat and corrosion.

Short-Run Stampings ..... Dayton A. Rogers 174

How short-run methods differ from usual tooling; size, shape and material limitations; 12 design tips for reducing costs; case histories with cost data.

Integral-Seal Ball Bearings ..... Carter T. Bragdon and Michael T. Monich 179

Analysis of types of seals; selecting the best combination of bearing and seal for life and performance; effect of temperature and speed; and design suggestions.

Photoelectric Controls 186

Seven typical applications for reducing production costs and increasing operator safety; automatic systems for controlling feed, transfer, or inspection of products.

Queueing Up ..... R. K. Prince 188

Laws governing the formation of lines and how they can be shortened.

Die Cast Insert Redesign Cuts Costs ..... Edward L. Kelly 193

How close tolerance was obtained on the exposed length of die-cast insert.

NEMA Rerate Motors ..... S. F. Henderson 195

Dimensional differences between old and rerated NEMA standards raises problem of motor interchangeability; dimensions for spacer bars for foot-mounted motors.

Hydraulic, Pneumatic and Electrical Energy Conversion ..... A. E. Maine 211

Two nomographs: electrical or mechanical power to air flow; hydraulic flow to electrical power.

DEVELOPMENTS TO WATCH...5
DESIGN PERSPECTIVES 123
EDITORIAL 127
TECHNICAL NEWS 198
COMING EVENTS 209
NEW COMPONENTS AND MATERIALS.....216
CATALOGS AND BULLETINS.....348
SANS, SOUCI 378
ENGINEERING ABSTRACTS...385
NEW BOOKS 410
READERS' LETTERS 447

Number of copies printed this issue 35,750

Mallory Rheostats Offer More Ratings... More Performance

THE Mallory line of rheostats, covering ratings from 25 to 500 watts, includes the largest selection of Underwriters' Laboratories approved rheostats on the market. You can be sure of getting the right rating and resistance value for your application . . . without need for "stretching" an undersized unit, or settling for an uneconomical oversized one.

Famous for long, trouble-free service, Mallory rheostats use high-stability ceramic insulation, and are designed for effective ventilation. Precision winding methods developed by Mallory assure superior linearity.

MINIMUM MAINTENANCE. The Mallory hinged contact lets you clean or replace the brush without changing contact pressure. Because the spring does not carry current, overloads cannot cause annealing of the contact spring arm.

VARIABLE PITCH WINDING, by special Mallory techniques, produces tapered windings from a single wire . . . eliminates hot spots and excessive wear at points where wire size changes . . . and reduces rheostat cost. In addition to standard types rated at 25, 50, 75, 100, 150, 225, 300, and 500 watts, Mallory will be glad to engineer special rheostats of single or multi-unit construction for your specific requirements. For complete technical data, write or call Mallory today.

Expect more . . .
Get more from **MALLORY**

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

THIS MONTH'S COVER

World's largest vertical testing machine inside Lehigh University's new Fritz Engineering Laboratory. Flexure tests of 5,000,000 lb, the machine's capacity, can be made on beams or girders 100 ft long. Specimens up to 40 ft high can be tested in tension or compression.

THE STAFF

Editor **G. F. NORDENHOLT**
Assistant to the Editor **JOSEPH KERR**
Managing Editor **ROBERT W. CARSON**

Associate Editors
RANDOLPH P. DOMINIC • E. T. EBERSOL, JR.
RICHARD M. KOFF • JAMES R. McDERMOTT

Assistant Editors **ROBERT E. ABBOTT**
PAUL N. ANDERSON • NICHOLAS CHIRONIS
JOHN KOLB • RICHARD A. LAWRENCE
NORMA J. VAN NESS

Editorial Assistant **LILLIAN M. WITHAM**
Consulting Editor **ROBERT E. BRUCKNER**
Washington **GEORGE B. BRYANT, JR.**

Publisher **ALBERT HAUPTLI**
Advertising Sales Manager **STANLEY J. ALLING**
Manager, Market Research **HUGH BRITTON**
Reader Service Manager **C. C. KANE**
Business Manager **RUSSELL T. DOUGLAS**

Foreign News Bureau: **LONDON • PARIS • BONN • RIO DE JANIERO • MEXICO CITY • TOKYO • BOMBAY**

Product Engineering
A McGRAW-HILL PUBLICATION

NOVEMBER, 1955 **Vol. 26, No. 12**

Published monthly, with an additional issue in Mid-October, by the McGraw-Hill Publishing Co., Inc., Executive, Editorial, Advertising and Subscription offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Publication office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President and Director of Advertising; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. Orders must indicate company and position. Allow one month for change in address.

Single copies 50¢. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $9 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Second class mail provisions authorized at Albany, N. Y. U. S. A.
Copyright 1955 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Developments

To Watch

FIBER METALLURGY . . . .

. . . . a new technique in metalworking, shows promise of leading to new metal applications. Starting from a short fiber form, many of the operations are the same as in powder metallurgy. However, tests comparing the powder and fiber products have shown that the fiber metallurgy bodies have significant advantages in tensile and impact strength. Also, it is possible to make parts having a wide range of porosities in addition to high strength and toughness. The metal fibers can be made as skeletons to support other materials, including plastics, ceramics, friction materials, and active catalyst masses. One unusual property of the metal fibers is that they can be used in the felting process similar to that used for making paper. The fibrous material is suspended in a liquid; then matted by pouring the mixture over a filter while applying suction. After drying, the fibers can be sintered, impregnated, or coined. The new fiber metalurrgy was developed by Armour Research Foundation of the Illinois Institute of Technology, and is available on a license basis.

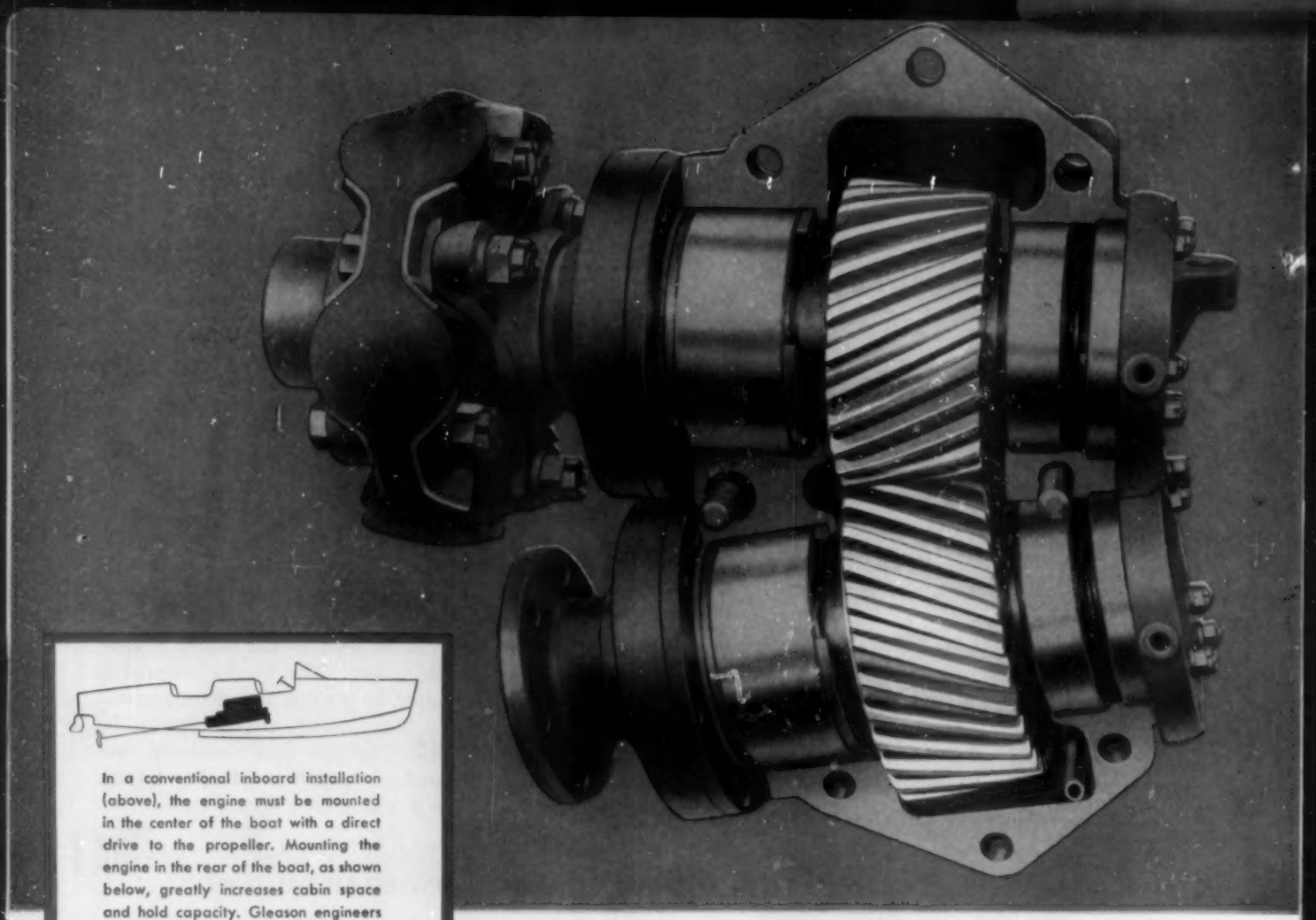
STRENGTH OF ADHESIVE BONDED METAL JOINTS . . . .

. . . . will closely approach the cohesive strength of the bonding agent itself if the metal surfaces have been properly treated. According to tests made at the Franklin Institute, Philadelphia, Pa., the strength of metal joints, when using high-strength adhesives can be correlated with the thickness of the contaminating film. For example: when rag-wiped aluminum sheets are bonded, the strength of a single-lap joint of $\frac{1}{16}$ in. metal ranges from 1,500 to 2,500 psi. If the surfaces are degreased, joint strength exceeds 3,000 psi. With all organic materials completely removed, joint strength reaches 5,000 psi. With titanium, rag-wiped surfaces give a joint strength of 1,400 psi; after degreasing, joint strengths jump to 4,000 psi. After completely removing the organic film, and leaving only an adsorbed water film, joint strength is about 7,000 psi.

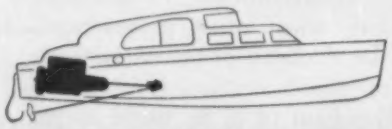
PREMIXED REINFORCED PLASTICS . . . .

. . . . is a new production technique that should expand the use of reinforced plastics—heretofore an expensive procedure caused by the large amount of hand layup work involved. Now, instead of manually laying up the layers of reinforcing materials and covering them with polyester resin, the two are pre-mixed in large batches, with any color pigment added. The compound is molded in matched metal dies using conventional molding presses. Because the glass fiber length is $\frac{1}{2}$ in., the strength of the part is not as high as that made from cloth or mat-reinforced parts. However, more complex parts can be made with the premix material at less

(*continued on page 7*)



In a conventional inboard installation (above), the engine must be mounted in the center of the boat with a direct drive to the propeller. Mounting the engine in the rear of the boat, as shown below, greatly increases cabin space and hold capacity. Gleason engineers assisted the Marine Engine Manufacturers in the development of the V-Drive.



Angular power transmission can improve *your* product, too

Take, for example, this marine V-Drive. The use of spiral bevel gears permitted a design which released more usable space in the boat, improved balance, and simplified installation.

This is just one instance of the added flexibility of product design possible with angular power transmission.

Faster production and lower costs will also result from using this type of transmission.

If you have a design application for bevel or hypoid gears, the Gear Engineering Department of the Gleason Works is ready to help you realize every advantage possible. Design and production recommendations for your angular drive are offered at no obligation.

If you would like to discuss your bevel gear application with a Gleason representative, please contact us.

These Gleason Technical Handbooks are available on request:

Spiral Bevel Gear System
20° Straight Bevel Gear System
Zerol® Bevel Gear System

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N.Y.

cost, and at a faster rate than other reinforced plastic parts. For applications requiring higher impact strength, sisal (a natural vegetable fiber) may be added. Varying wall thicknesses, which had to be avoided in lay-up techniques, are possible. Premix compounds have limited storage, and should be used soon after mixing. The properties of the premix molded parts have a greater variation than the preform or mat molded parts, and much care should be taken to get representative test values. PE-55, a polyester resin developed for premix molding by the Barrett Div. of Allied Chemical & Dye Corp., has the following properties with premix formulations: water absorption after 24 hrs, 0.15 per cent; flexural strength, 12,300 to 19,400 psi at 78 F, and 4,000 to 10,900 psi at 200 F; modulus of elasticity in flexure 1.39 - 1.92 x 10^6 at 78 F, and 0.45 - 0.57 x 10^6 at 200 F.

SMALLER RADIO-ISOTOPE CAMERAS . . . .

. . . . which can be carried and operated by one man, will permit examination of pipe lines, pressure vessels, heat exchangers, and similar equipment in out of the way places. Designed by the M. W. Kellogg Co. and sold by the Metal & Thermit Co. of New York, the smallest model weighs 75 lb. and uses either Cobalt 60, Cesium 134, or Iridium as the radio-active source. The camera is safe to operate, costs less than comparable x-ray equipment used for this work, is portable, needs no electricity, no control board, and no maintenance beyond the replenishment of the radio-isotope, and can take a picture of 360 degrees. The camera is shielded with lead, with the thickness of the walls depending on the strength of the isotope used. It has a lensless shutter that can be opened and closed remotely. To check the weld of a large vessel, x-ray film in a continuous strip is placed around the weld on the outside, and the camera positioned inside. Gamma rays from the camera penetrate the metal and expose the film. Length of time to take a picture through 8 in. of alloy steel is 15 minutes.

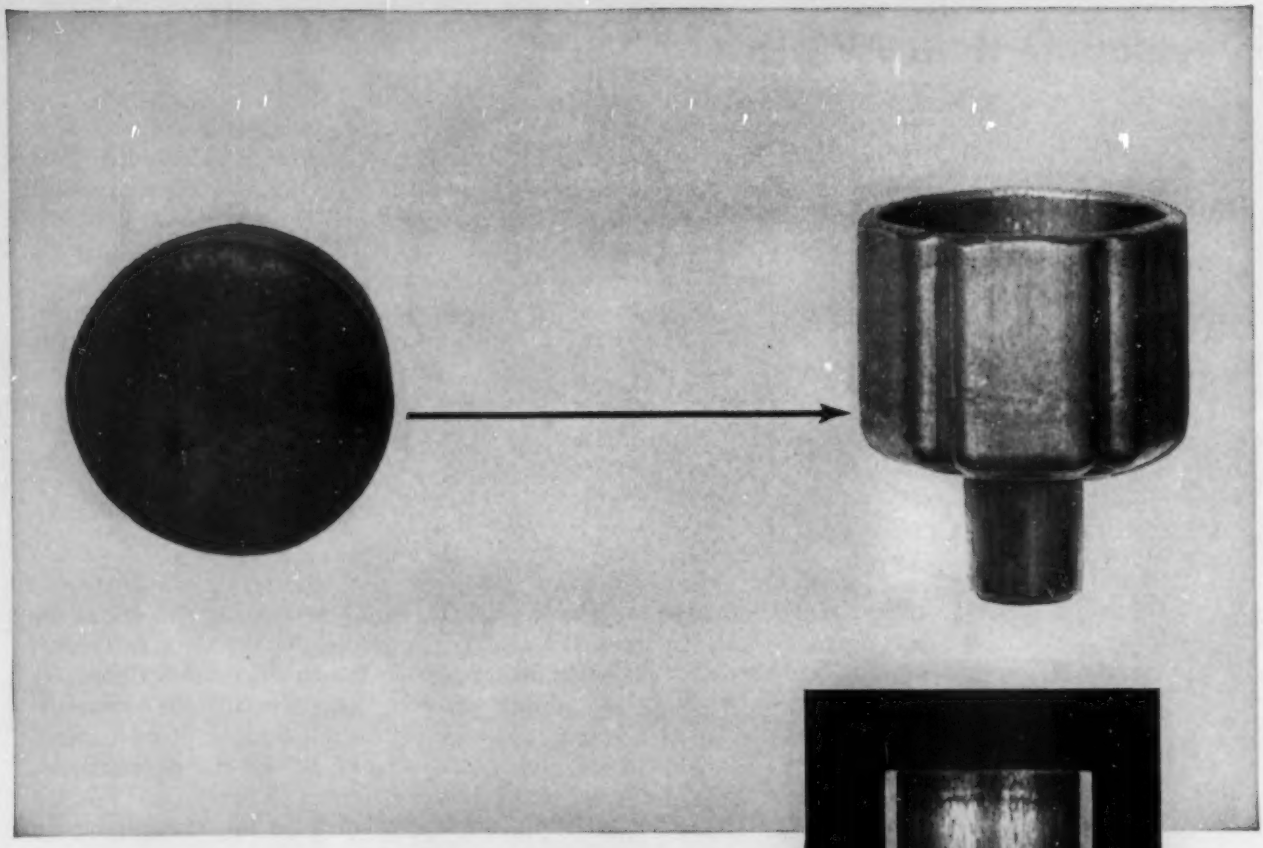
A NEW MAGNETIC CORE MATERIAL . . . .

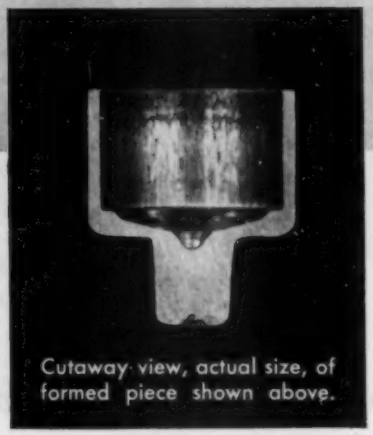
. . . . for amplifiers and other devices, including electronic computers has been developed at the General Electric Research Lab., Schenectady, N. Y. The new high permeability alloy is called Dynamax, and quality control of production quantities and various modifications is under study. To retain good magnetic qualities at high temperatures, a special technique was developed for adding molybdenum to the "soft" nickel-iron alloy. G.E. claims that cores of control devices may be matched more easily with the new alloy than with conventional materials.

USING THE KOLDWELD PROCESS TO SEAL TRANSISTORS . . . .

. . . . and other semiconductors in cans to prevent contamination, avoids the risk of any damage to the operating part either by heat or some material like the soldering flux. The General Electric Co., Ltd. of England (no relation to G.E. in this country) is manufacturing these units using the Koldweld process to seal the base to the housing. This has been found to be helpful where the operative part of the device has a portion of Indium, an easily fused material. Also, G.E. Ltd. has found that this sealing operation can be accomplished easily in an inert atmosphere such as dry nitrogen. Controlled by a foot switch, the sealing is done in one press operation. Rejects are said to be greatly reduced. Koldweld is a patented process of the Koldweld Corp., 10 E. 40 St., N. Y. 16, N. Y.

(*Continued on page 9*)





Cutaway view, actual size, of formed piece shown above.

COLD FORMED IN ONE OPERATION

—with Bonderite and Bonderlube!

An experienced production man looked at this blank and the formed parts and said flatly, "It can't be done!" But *it is being done* — in one operation — on a production basis of thousands of units per day.

The blank is treated with Bonderite, and then with Bonderlube. This combination works with remarkable effectiveness.

These two Parker products effect big savings in other ways besides raising production levels. Tool and die breakage declines sharply, fewer process anneals are necessary, operation is simplified, scrap is minimized, and machining operations are reduced.

Cold extrusion, with Bonderite and Bonderlube, may hold the key to cost-cutting for you. Write for information!

**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.*

Since 1915—Leader in the Field

1915 40th year 1955

PARKER RUST PROOF COMPANY

2179 E. Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Developments to Watch

FROM BLUEPRINT TO FINISHED PART . . . .

. . . . by the "cam machine," doing in from 2-4 hours an operation which previously required 400 manhours, or from 5-10 weeks. At Bendix Aviation Research Lab., where the machine was invented, the device has been used to automatically produce a complicated cam used in a jet engine fuel-metering and fuel-control system. The machine converts the blueprint into a finished product with an electronic computer and servo devices linked to a machine tool. Coded information taken from the blueprint is punched onto a paper tape, and the computer then analyzes the data as to the shape of the required cam and sends the instructions to the machine tool doing the cutting. The computer checks itself for error and makes adjustments as needed.

STRETCHABLE ELECTRIC WIRE . . . .

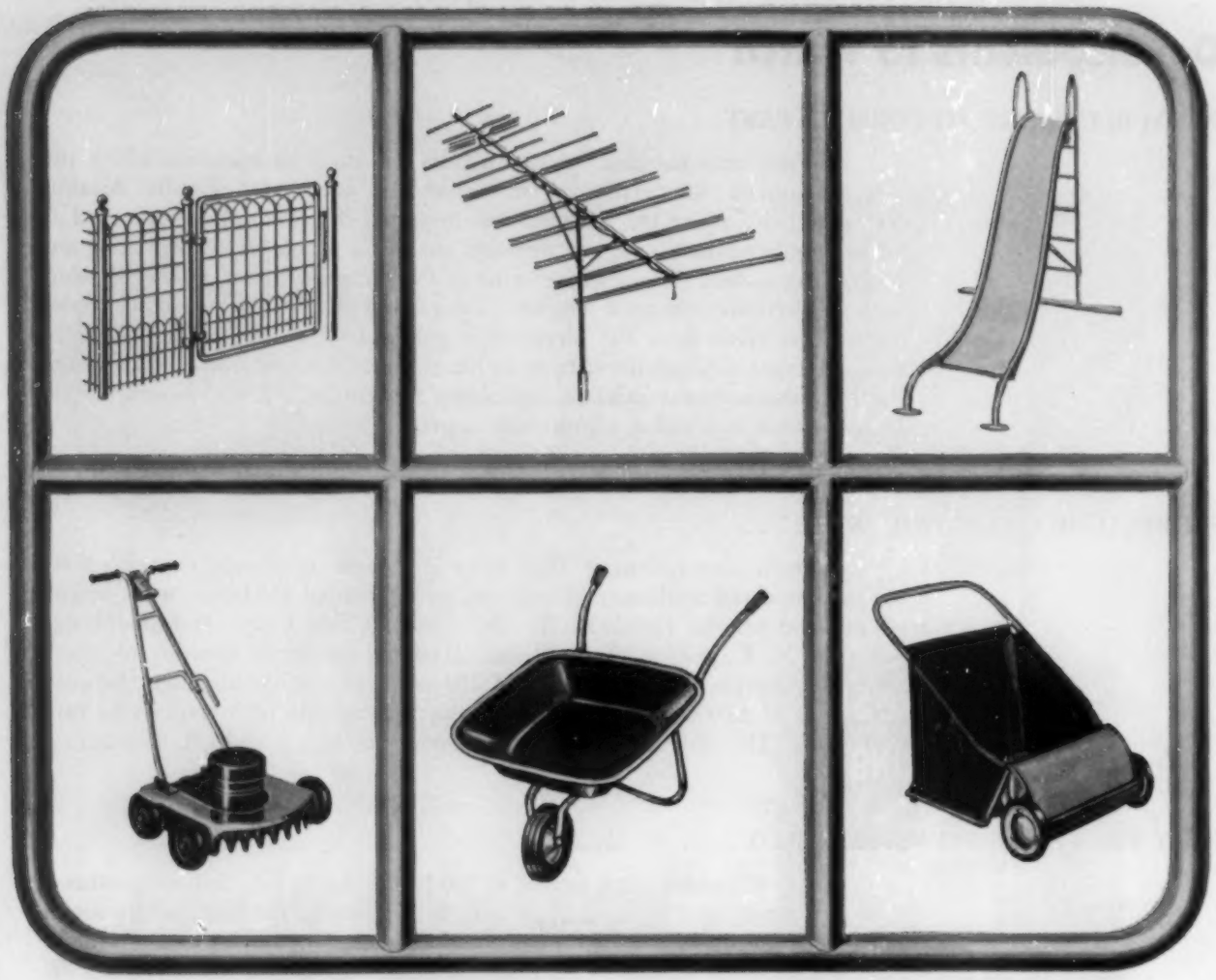
. . . . which stretches more than twice its length is already considered for use on household appliances, telephones, rack mounted electronic units, microphones and others. Developed by the United Cable Corp., Harwood Bldg., Scarsdale, N. Y., it is made of braided 21 strand conductor covering of rayon, nylon or rubber with an expansion of 200 per cent. It has insulation between conductors of 1,000 volts and a current carrying capacity of 5 amperes in twin conductors. The cable comes in one to 6 conductors, in 2, 3, and 4 ft. lengths.

HEAT TREATABLE TITANIUM ALLOY . . . .

. . . . Ti-6A1-4U, which when treated at 900-1000 F for 24 hrs., following either a 1550 F (1 hour), or 1750 F (1 hour) and water quench, was found to be useful at temperatures up to 800 F without embrittlement. The duplex heat treatment was found essential to stability. Tensile strengths ranging from 136,000 to 165,000 psi were obtained, with yield strength (0.2 per cent offset) of 128,000 to 142,000 psi. Elongation values were over 15 per cent. This alloy can be forged at 1900 F for heavy sections.

AND IN ADDITION . . . .

. . . . Four new types of germanium transistors have been designed especially for general purpose switching and computer applications by Texas Instruments, Inc., Dallas 9, Texas; rise time is 0.15 microseconds, and cutoff time 3.5 microseconds. . . . Methyl Styrene, a new plastic developed by American Cyanamid Co., is chemically related to polystyrene, but is said to be superior to it in many respects because it is tougher and withstands high temperatures; is not brittle, and will not soften in boiling water. . . . Aluminum Co. of America is now offering sheet, extruded shapes, rod, bar, and drawn and extruded tube in either anodized blue, green, yellow, gray, brown, gold, and black metallic colors; actually part of the metal itself, the colored aluminum can be supplied for indoor and outdoor use. . . . A putty consisting of 80 per cent aluminum and 20 per cent plastic is being used to fill holes and build up worn sections in aluminum and steel; made by Chemical Development Co., Danvers, Mass., it hardens to a permanent bond. . . . Monarch Aluminum Mfg. Co. and Selas Corp. of America have developed a furnace for continuous casting of aluminum alloys. . . . Bell Telephone Labs. has a variation on its zone melting process in which the molten zone moves through a solid by impressing a stationary temperature gradient across the solid; new process will grow crystals; bore fine holes in solids; purify and alloy metals; and permit fabricating of semi-conducting devices.



Special Zinc-Coated ARMCO TUBING

May Improve Your Products, Too

A new kind of material is now going into the products you see here.

It is Armco ZINCGRIP Tubing. Besides being modern looking, it gives these products the unbroken rust protection of a hot-dip zinc coating, along with the strength of welded tubing.

This welded tubing is made of Armco ZINCGRIP, a special steel coated on both sides with zinc by a patented process. Even the welding flash is planed away on the outside, and a new zinc coating applied to form an almost invisible seam.

What's more, the special coating stays on when Armco ZINCGRIP Tubing is bent or twisted into shape by the manufacturer. There are no zinc-bare spots where rust can get a quick start.

Armco ZINCGRIP Tubing is made in outside diameters of ⅜-inch through 3 inches, with wall thicknesses of 20 gage through 12 gage. For information and prices, just fill out the coupon and mail it to us.

Armco Steel Corporation, 1615 Curtis St., Middletown, Ohio
We manufacture_____
Send me information on Armco ZINCGRIP Tubing ☐
Quote me on:
_____ feet_____ gage_____ diameter _____length

NAME:_____

FIRM:_____

STREET:_____

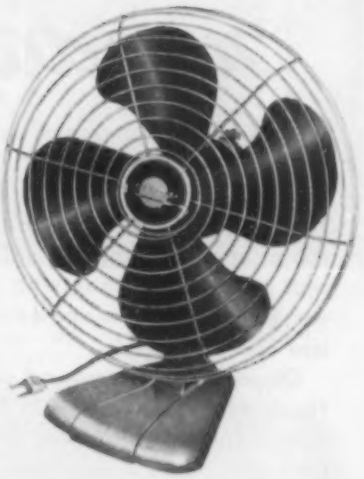
CITY:_____ZONE:_____STATE:_____

ARMCO STEEL CORPORATION 1615 CURTIS ST., MIDDLETOWN, OHIO

SPECIAL STEELS

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

The Chicago Electric Division of THE SILEX COMPANY calls G. S. whenever they need Small Gearing. Among the many excellent appliances they make is the attractive Handybreeze SAFE-T-GUARD FAN. You see it pictured here, together with the Small Gearing designed and manufactured by G. S. The correct design and extreme uniform accuracy of this Gearing assures extra years of smooth, quiet, dependable performance. ★ Do as Chicago Electric and so many others are doing . . call our engineers while the project is on the boards. Let them recommend the best and most economical Gearing for the job. This valuable consulting service costs you nothing and *may save a lot.* Write today!



SEND FOR.. our 6-page Small Gearing Guide. It describes 80 types and applications. Contains useful charts . . a valuable aid to anyone interested in Small Gearing. Use company letterhead, please. No obligation, of course. Write today!

40 Years of Specializing in Small Gearing!

FRACTIONAL HORSEPOWER GEARS

GEAR Specialties, Inc.

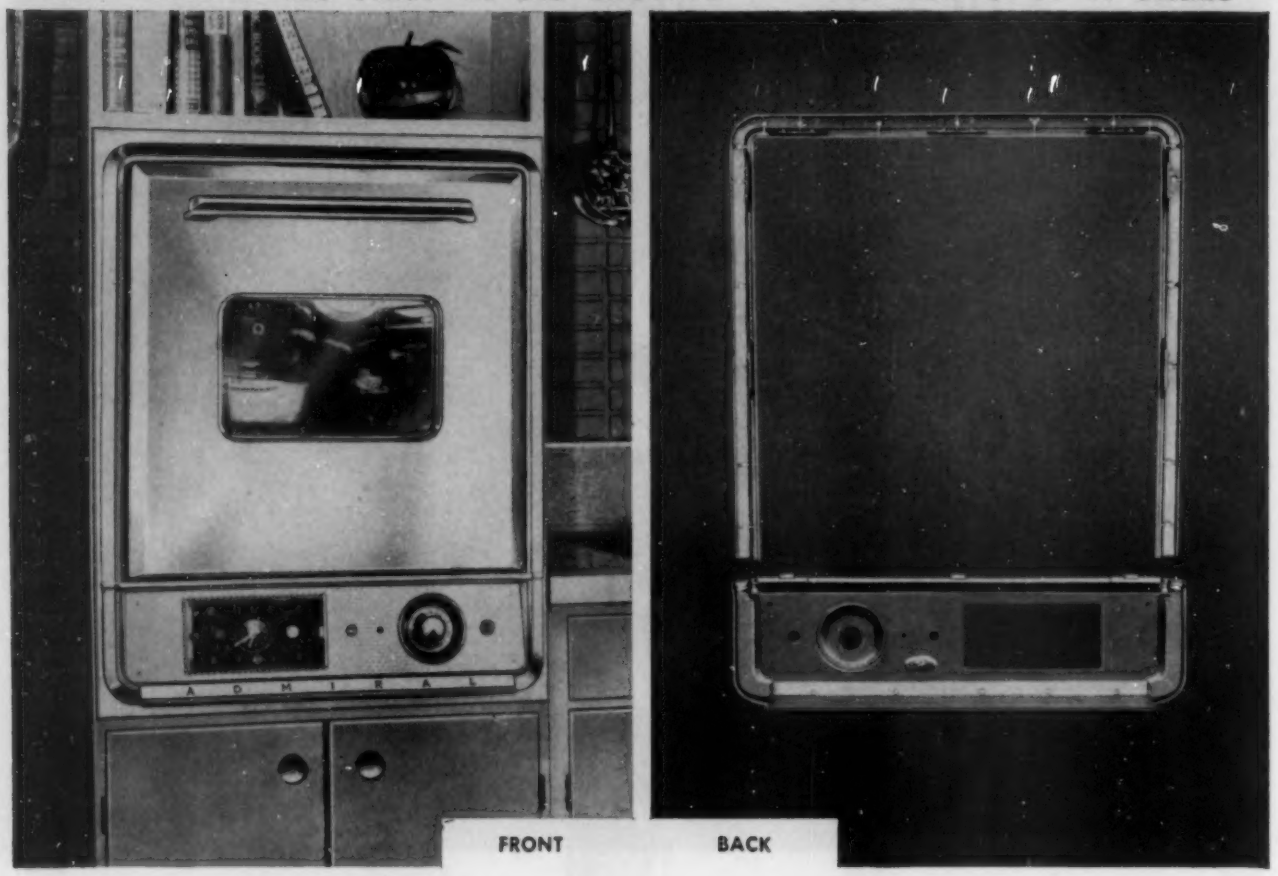
Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

WHY ZINC RATES FIRST IN DIE CASTING • NUMBER 6 OF A SERIES



FRONT BACK

rigidity – as needed by *Admiral*

Built-in electric ranges and wall ovens are the latest products of the fertile minds of appliance designers. And the most efficient methods and materials are employed for each component of the new space-saving cooking units. The illustrated custom wall oven by Admiral, with its ZINC die cast inverted-U door frame and control panel, is an excellent case in point.

Obviously the frame and panel (back views above) could have been stamped from sheet metal, but not with the qualities and economies of these ZINC die castings. Stampings not only would lack the desired rigidity, but would not possess the following additional advantages obtained with die castings:

1. No scrap loss
2. Integral mounting bosses for easy assembly
3. Dimensional accuracy for perfect fit of mating parts
4. Bold raised lettering on the control panel
5. Smooth as-cast surfaces which—being ZINC—take, and hold, beautiful chromium plating applied by commercial methods

Watch for other examples of ZINC die casting economies in our future advertisements. Send for our brochure and contact any commercial die caster for the answers to your particular production problems.

ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front Street, New York 38, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

For longer chain life, here's less bushing and joint wear

Large-diameter rollers of Link-Belt SS chains reduce chain-pull due to frictional resistance.

Link-Belt Class SS roller chain assures steady, even flow of fabricated products from medium-temperature industrial oven manufactured by The W. W. Sly Manufacturing Co., Cleveland, Ohio. Link-Belt precision steel roller chain and roller bearing blocks are also used.

LINK-BELT SS roller chains are designed for abrasive, heavy-duty service

FOR hard-working drives and conveyors, choose Link-Belt SS bushed roller chain. Its hardened steel joint assures longer life in gritty and abrasive applications. Accurately machined parts provide a firm, tight fit of pins and bushings in the steel sidebars. In addition, accurate control of raw material specifications and manufacturing processes results in uniformity . . . longer life.

Whatever your particular chain requirements in regard to speed, weight of loads or severity of service—the completeness of the Link-Belt line will provide the right answer. No other manufacturer offers such a broad range of silent and roller chains—of cast, combination, forged and fabricated types. And a complete selection of attachments permits efficient adaptation to varied services.

For help with any chain problem—big or small—call your local Link-Belt office. They are qualified to make an unbiased recommendation of the one chain best-suited to your exact needs.

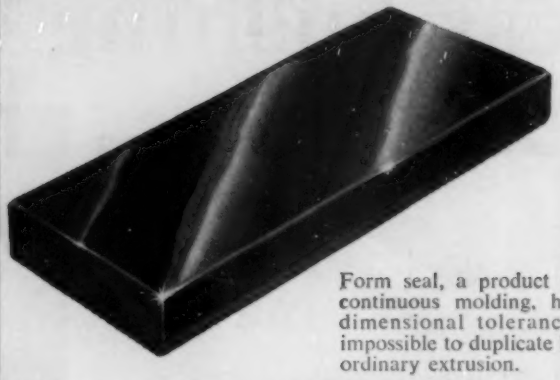
LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 12,889-A

Look what "U. S." CONTINUOUS MOLDING does!

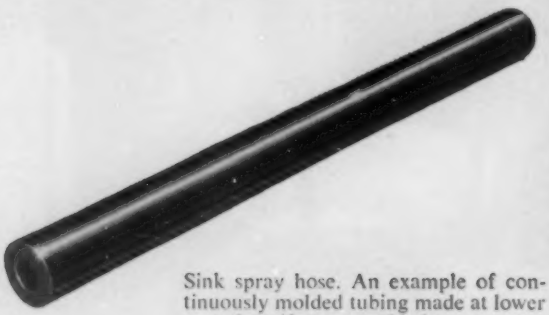
Auto body bumper. Such complexity of design and dimensional precision in an engineered rubber part cannot be obtained by ordinary extrusion. "U. S." continuous molding achieves it.



Form seal, a product of continuous molding, has dimensional tolerances impossible to duplicate by ordinary extrusion.

Rubber automotive door seal. Here is remarkable complexity of design—*in a low durometer stock*. "U. S." continuous molding produces it.

Continuously-molded seal strips. An example of high dimensional accuracy and precision in *long* lengths (up to 500 feet).



Sink spray hose. An example of continuously molded tubing made at lower cost than if press molded.

Window channel. A complex highly flexible shape, produced in *long* lengths. Only continuous molding can produce this.

Components of motor mounting... first ever made by continuous molding.

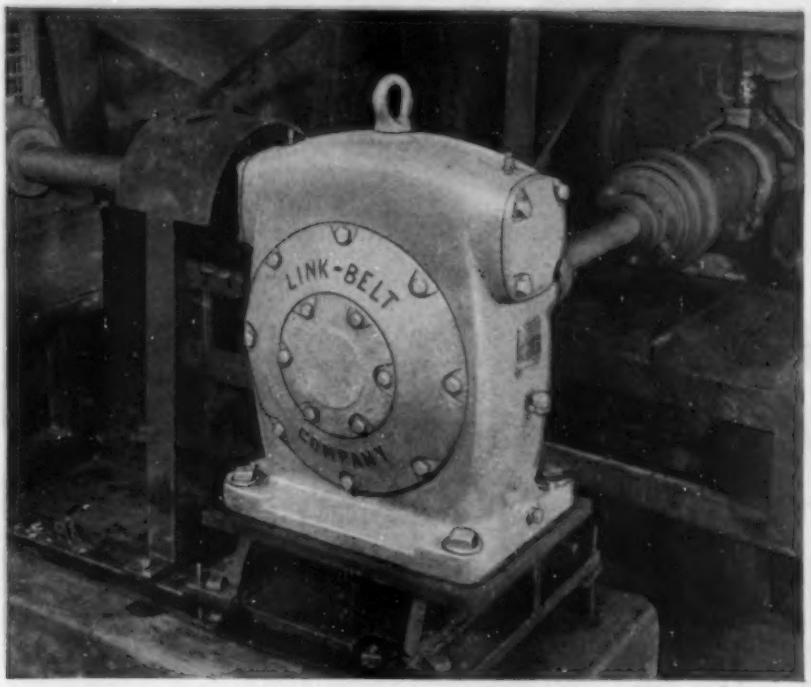
Continuous molding is done only by United States Rubber Company. This great new process produces parts of natural rubber as well as synthetic rubber (GR-S, Neoprene or Nitrile) that are equal or superior to cavity-molded items. Get in touch with us at Rockefeller Center, New York 20, N. Y.

US RUBBER

Mechanical Goods Division

United States Rubber

Here's industry's most comprehensive line of WORM GEAR DRIVES



Reel at the wind-up end of paper machine is driven through a dependable Link-Belt Worm Gear Drive.

Type WB — Single reduction, worm below gear, horizontal output shaft.

Type WV — Single reduction, vertical output shaft (up or down).

Type HWB — Helical gear first reduction, worm gear final reduction. Worm below gear, horizontal output shaft.

Type HWV — Helical gear first reduction, worm gear final reduction. Vertical output shaft (up or down).

Type DWB — Double worm reduction gear, horizontal output shaft.

Type DWV — Double worm reduction gear, vertical output shaft (up or down).

Type WVS — Single reduction, worm on top of gear, horizontal shaft with screw conveyor flange.

Type WVT — Single or double reduction overhead conveyor drive.

FOR efficient, high-ratio, right-angle speed reductions, choose from the complete Link-Belt line of worm gear drives. A wide selection of single-worm, double-worm and helical-worm gear reductions assures you of the best drive for large and fractional horsepower requirements.

All three types are available with horizontal and vertical housings to permit convenient, compact connections to prime movers and driven machinery. And a choice of two shaft diameters facilitates direct connection or the accommodation of heavy overhung loads.

Single Worm Gear Drives are offered in ratios from $3\frac{1}{10}$:1 to 100:1 with output capacities up to 97.9 hp.

Helical Worm Gear Drives are available in ratios from 26:1 to 540:1 — output capacities up to 56.7 hp.

Double Worm Gear Drives have ratios from 26:1 to 8000:1—output capacities up to 26 hp and 124,800 inch pounds torque.

Get all the facts on Link-Belt Worm Gear Drives. Contact your Link-Belt office or authorized stock-carrying distributor. Or write today for Book 2324-A.

LINK-BELT

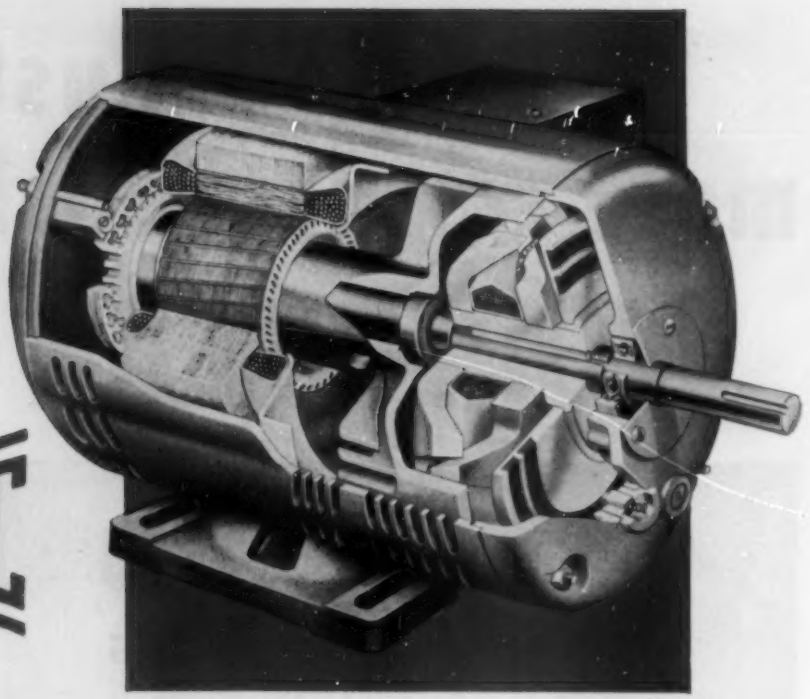
ENCLOSED DRIVES

13,673

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

EATON

DYNAMATIC®



Stepless Adjustable Speed from an AC Power Source with Dynamatic Fractional HP Ajusto-Spede® Drives

These famous Ajusto-Spedes®—available in sizes ranging from ¼ HP to 75 HP—provide the solution to many drive problems at surprisingly low cost.

Fractional HP Ajusto-Spedes® are compact, self-contained units, an integral combination of AC constant speed induction motor, eddy current coupling, and electronic control.

All fractional horsepower Ajusto-Spedes® are rated 115/220 volts, single phase or 220/440 volts, 3 phase. Sizes are ¼, 1/3, and ½ horsepower at 1600 RPM; ½ and ¾ horsepower at 3200 RPM.

Write for your copy of the Dynamatic Ajusto-Spede® Bulletin FAS-4

Ajusto-Spede® Advantages:

- ★ Constant torque speed range: 25 to 1 with 1600 RPM and 3200 RPM Ajusto-Spedes®.
- ★ Control accuracy: 2 per cent of top speed at any point within the speed range.
- ★ Minimum wiring to power line.
- ★ Remote "one knob" control operation up to 100 feet.
- ★ Rugged plug-in type integral one-tube electronic control.
- ★ Permanently sealed grease-packed bearings.
- ★ Power output shaft extension at both ends of drive.

EATON MANUFACTURING COMPANY
DYNAMATIC DIVISION
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

NEW ATOMIC CANNON

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

This mobile 280 mm. atomic cannon has *two* recoil motions. The primary recoil absorbs the cannon's "kick". The secondary recoil (something new in artillery) absorbs the forces created by the primary recoil. And each recoil motion is recorded by this special Veeder-Root Counter designed with a plunger-action shaft . . . which keeps the score on the cannon's use and indicates approaching need for maintenance.

This again points up the fact that "Anything Worth Making — or Worth Doing — *Is Worth Counting.*" And Veeder-Root has the experience and resources *you* can count on, to give you any counter you need . . . for any mechanical or electrical application . . . in any field from Atomics to Automation. Write:

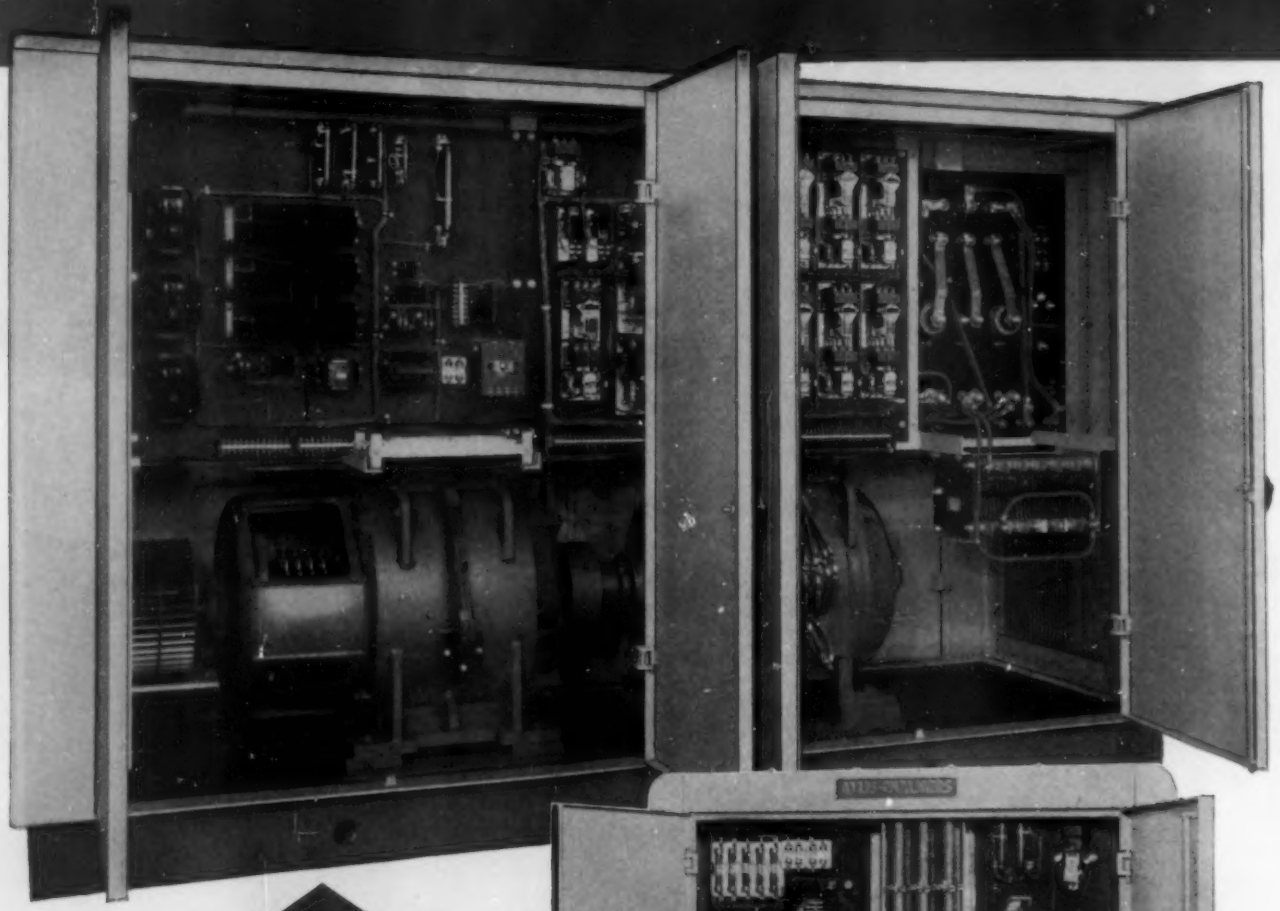
VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

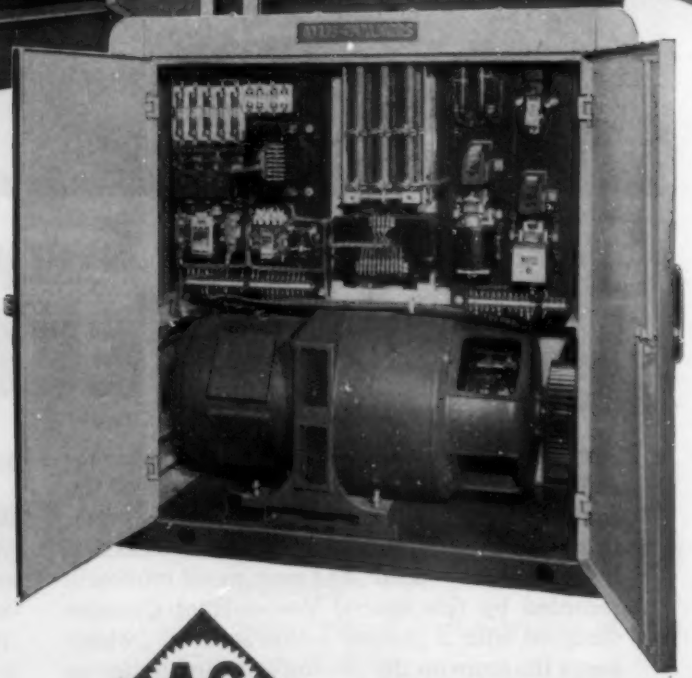
"The Name that Counts"

Get the Drive

Tailored to Your Speed



A-C package drive, Size 5, 125 hp. Reversing, dynamic braking (rear view).



Size 2 packaged drive, 25 hp, with electronic speed regulation ¼ of 1% based on top speed, 3550/50 rpm.

A-C ALLIS-CHALMERS

ALLIS-

Control Needs

ALLIS-CHALMERS Package Drive Gives You

★ Wide speed range

★ Precise speed control

★ Operation from one or more points

★ Simple installation

★ Reduced maintenance

If you need speed control for up to 200 total horsepower plus special performance characteristics such as threading, jogging, dynamic braking, etc., the Allis-Chalmers package drive will provide these functions in one easy-to-specify unit. The package drive itself consists of a motor-generator set and control components mounted in a well-ventilated cabinet. Control stations and dc drive motors may be placed wherever convenient. Installation is simple because the unit is factory-wired and ready to operate. Maintenance is reduced because cabinet keeps equipment clean and out of harm's way. All three of the basic components — m-g set, control and drive motors — are designed to operate as a unit.

Engineering Assistance

Allis-Chalmers application engineers are thoroughly familiar with OEM problems and will be glad to help you at every stage of your operation. For help, call your nearby Allis-Chalmers District Office. For literature, write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B8166. A-4620

Vari-Pitch is an Allis-Chalmers trademark

Other Allis-Chalmers Speed Control Drives

Mechanical

Where a moderate speed range is required and where the machine may be stopped to make required speed changes. Horsepower range — 1½ to 300. Speed adjustment range — 9 to 28 percent. Two *Vari-Pitch* sheaves used together double range of adjustment.

Mechanical

Where speed must be changed while machine is in motion. Particularly good for machines requiring fine adjustment while operating. Double range of adjustment may be obtained by using two *Vari-Pitch* sheaves. Horsepower range—1½ to 600. Speed adjustment range —9 to 28 percent with one *Vari-Pitch* sheave.

Electrical

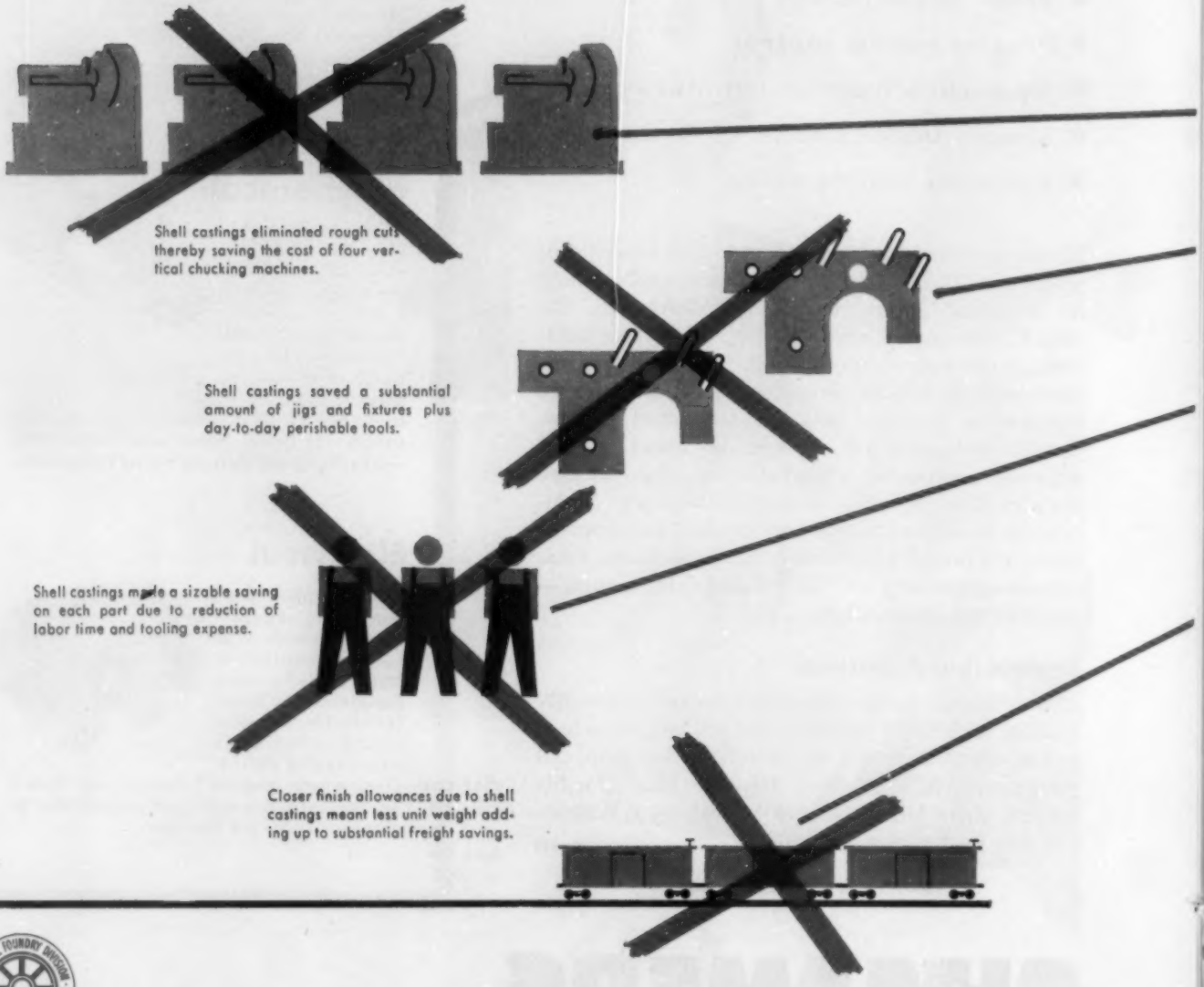
Where stepped speed control is satisfactory. Available with stepless control in larger sizes by using liquid rheostat. Speed is varied by means of control on secondary windings of motor. Horsepower range — 5 hp and up. Speed adjustment range — 30 to 96 percent of synchronous speed for fan duty.

CHALMERS

LOOK AT THESE

MADE ON THIS STATOR WITH CENTRAL FOUNDRY

By having it shell-cast by Central Foundry Division, savings on this Stator Blade Carrier were effected in six figures. With the shell casting process finish allowances were reduced so that preliminary rough machining was eliminated and only finishing machine operations were required. Thus machinery, tools, and man-hours and even freight were substantially reduced. The savings made on this grey iron part are typical of what uniform Central Foundry Division shell castings can do for you. Obviously, savings are the greatest . . . as they were here . . . when the original design is planned for a shell casting, before tooling up.



Shell castings eliminated rough cuts thereby saving the cost of four vertical chucking machines.

Shell castings saved a substantial amount of jigs and fixtures plus day-to-day perishable tools.

Shell castings made a sizable saving on each part due to reduction of labor time and tooling expense.

Closer finish allowances due to shell castings meant less unit weight adding up to substantial freight savings.

CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION

54

CENTRAL FOUNDRY DIVISION

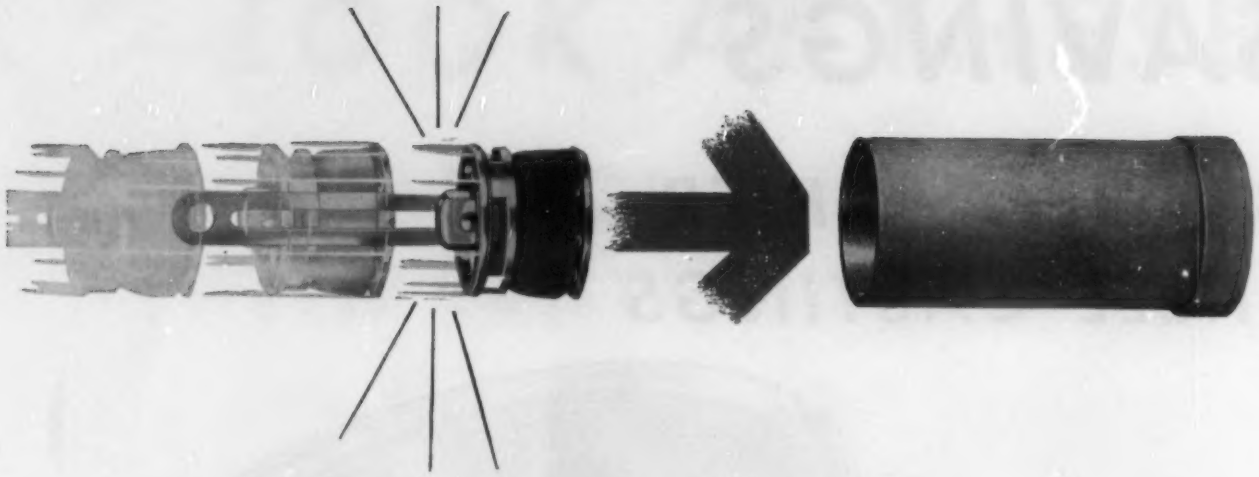
$AVING$

BLADE CARRIER SHELL CASTINGS

There are many advantages from Central Foundry Division shell castings. Parts too difficult in contour for the green sand method can be held to close dimensional uniformity on a production basis. The improved casting surfaces and uniformity of a shell casting often eliminate machining on non-functional areas. Excessive tool wear caused by sand particles in the surface is eliminated because the thin shell of sand used as a mold is bonded by a thermo-setting plastic which results in clean, sand-free castings.

For further information about either shell or sand casting or about any type of castings in grey iron, malleable iron or ArmaSteel write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10



How to soak up shock and

Underwood Corporation did it by using Republic ELECTRUNITE Stainless Steel Tubing

This was the problem: find a material for the cylinder in the carriage shock absorber on an accounting machine. The cylinder must have an accurate bore, little variation in diameter, and negligible eccentricity. It must also have a suitable finish to reduce drag, because the piston which fits inside must be completely retracted in less than a tenth of a second.

Republic metallurgists suggested ELECTRUNITE Stainless Steel Tubing. It was drawn to meet dimensional requirements. The finish was excellent. And Underwood reports good service life because of excellent wearing qualities.

Republic Steel Corporation
3150 East 45th Street
Cleveland 27, Ohio

REPUBLIC STEEL

- ☐ Enduro® Stainless Steels
- ☐ ELECTRUNITE® Stainless Steel Tubing and Pipe
- ☐ Republic Nuts and Bolts
- ☐ Republic Chateaugay Pig Iron

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

E-7068

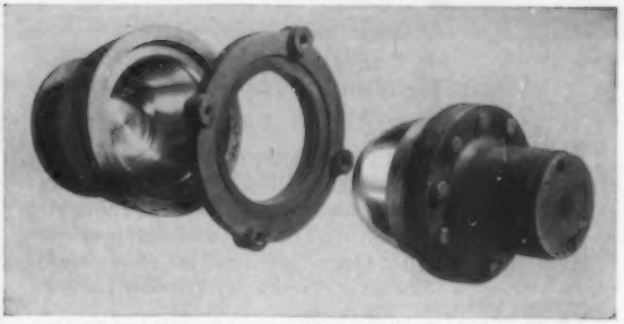
BUSINESS MACHINE PARTS COST LESS because they last longer when they're made of Republic Enduro Stainless Steel. On this Addressograph-Multigraph office machine, ink corroded the carbon spring steel from which the ribbon guards and lister spacing bands were made originally. Carbon steel also cracked under the operating strain. Enduro Stainless Steel resists this corrosion, has the necessary springiness and wears well, despite the abrasive action of moving the ribbon.

cut costs!

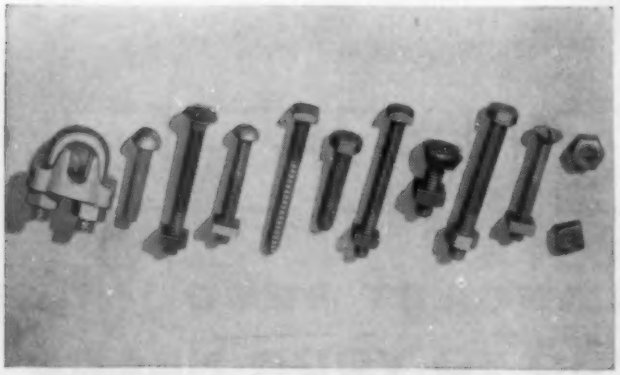
Underwood now saves 75 cents on material costs for each shock absorber.

This is only one of many customers for whom Republic has saved money. Sometimes we save material costs. Sometimes production costs. Often, both. And since we manufacture both stainless steel and carbon steel tubing in many analyses, we are equipped to help solve all kinds of tubing problems.

Fill out the coupon below for more facts on Republic ELECTRUNITE Mechanical Tubing. Or call your nearest Republic district sales office.



ECONOMICAL MACHINING IS ONLY ONE REASON why a leading maker of heat-resistant glass products uses Republic Chateaugay Pig Iron for glass molds. This premium pig iron, supplied exclusively by Republic, also assures a dense, fine grain structure; longer mold life; fast-flowing and even-cooling characteristics. Hard surfaces resist heat and wear.



CUTTING COSTS ALSO APPLIES TO BUYING FASTENERS for your assembly and maintenance work. One call to your Republic Distributor gets all the fasteners you need. There's no shopping around, no time lost. Paper work is reduced. And, you get exactly what you want because Republic makes and stocks over 20,000 types and sizes of regular fasteners, everything from machine bolts to sheet metal screws. You can depend on Republic Fasteners for quality, uniformity, ease of application, long service life. Quick delivery, too.

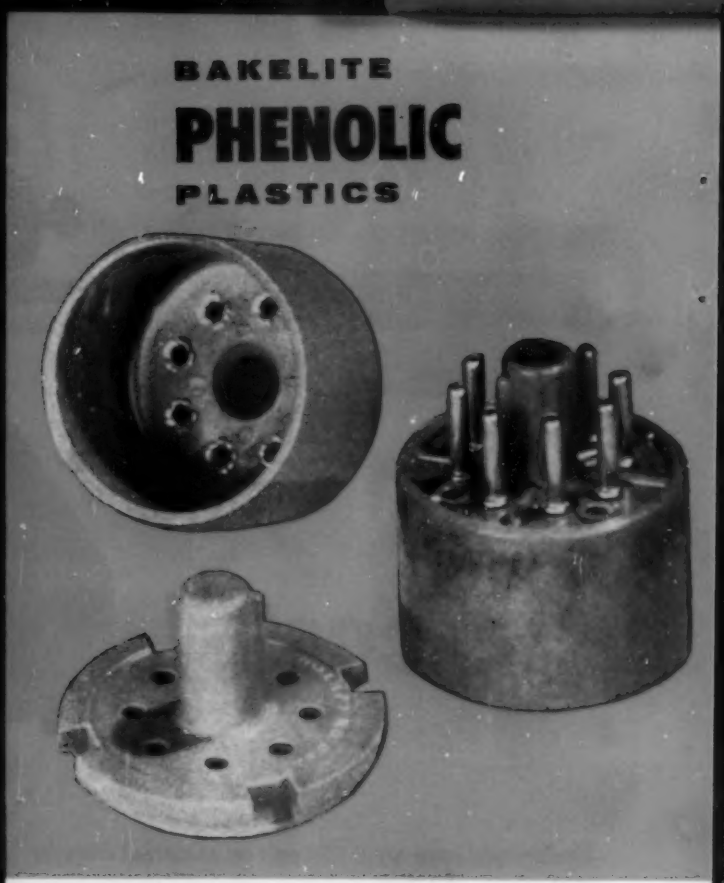
REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

Road markers by
Plastic Engineering Inc., Cleveland 2, Ohio

This bright red molded road marker makes good use of the inherent toughness of BAKELITE Brand Vinyl Elastomeric Plastics. It's virtually immune to rough treatment. The color goes completely through, can't be scuffed off. The pyramid shape and the correct specific gravity of the plastic keep the marker in place when it's set over a freshly-painted traffic line.

BAKELITE Vinyl Elastomeric Plastics stay resilient even at below-zero temperatures. Their flexibility can be varied from semi-rigid to soft, depending on the amount of plasticizer used in their formulation. A wide range of colors is available. These materials are faithful to mold details and provide high surface gloss.



Vacuum tube bases molded by
Sylvania Electric Products Company, Warren, Pa.

With its excellent high-frequency insulating characteristics, BAKELITE Brand "Low Loss" Phenolic BM-17748 is an ideal material for these molded vacuum tube bases. For example, its minimum dielectric strength is 325 volts/mil, while power factor ranges from 0.025 at 60 cycles down to 0.010 at 1,000,000 cycles. Consequently, this material is recommended for a wide range of electronics applications including coil forms, resistors, and capacitor housings.

BM-17748 is also more resistant to moisture and more dimensionally stable than most phenolic molding materials. It can be used not only where its outstanding electrical properties are paramount, but also in a variety of other applications where these additional service properties are useful.

BAKELITE

TRADE-MARK

GREATEST VARIETY, LARGEST RESOURCES FOR PLASTICS KEYED TO YOUR NEEDS

Your product, its sales and profits depend in great measure on the quality of the materials you specify. That's why so many molders and fabricators rely on Bakelite Company for their basic requirements.

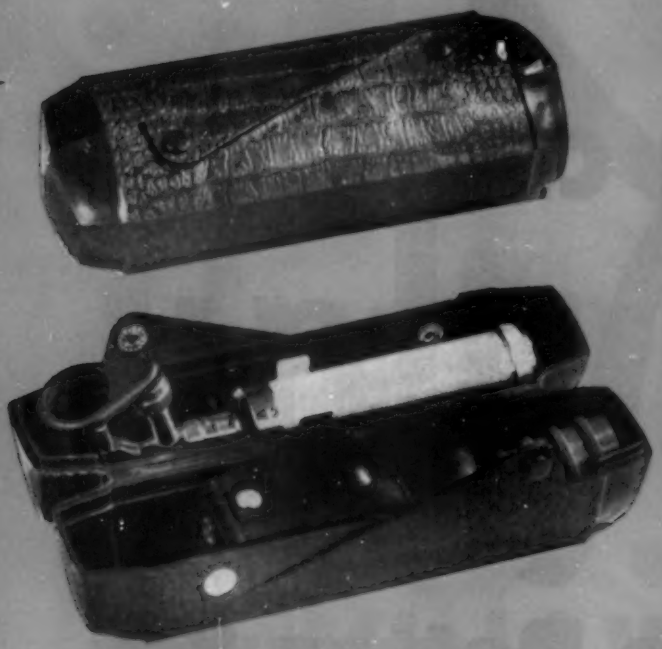
At this one source you can select plastics with properties best suited to your product needs, because Bakelite Company offers the greatest variety of the large volume plastics.

In addition, Bakelite Company engineers—backed by over 45 years of plastics research—offer technical advice or assistance whenever you need it. If you have a problem in materials selection or processing, talk it over with the Bakelite Company sales representative nearest you. Or write Dept. JI-145.

BAKELITE

POLYETHYLENE

PLASTICS



Instrument case molded by **Auburn Button Works, Inc.**, Auburn, N. Y., for Welch-Allyn, Inc., Skaneateles Falls, N. Y.

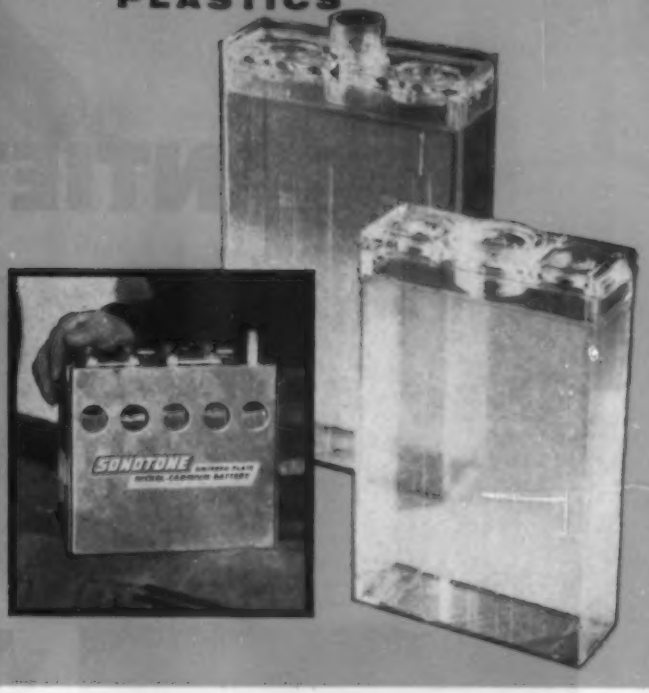
Cleverly designed, this entire case for diagnostic instruments is one-piece molded of BAKELITE Brand Polyethylene. Compartments, hinge, flaps, and the simulated alligator surface were all formed in a single operation. In service, the resilient polyethylene makes the case shock-proof and virtually indestructible. It can be sterilized in standard germicides; polyethylene is inert to most chemicals.

Although lightest of all commercial plastics, BAKELITE Polyethylene provides husky construction. It's tough and flexible, even at –70 degrees F. Other advantages include outstanding dielectric properties, making it an especially important extrusion material for wire and cable construction.

BAKELITE

C-11

PLASTICS



Cell cases molded by **Plastic Mold and Engineering Co.**, Providence, R. I. for Sonotone Corp., Elmsford, N. Y.

These battery cell cases, molded of BAKELITE Brand C-11 Plastic, are designed to give many years of service, according to the manufacturer. The plastic, an acrylonitrile-styrene copolymer, is so chemical-resistant that it withstands contact with highly corrosive electrolyte—a 30%-by-weight solution of potassium hydroxide in distilled water. It's so tough that a "shake test" shows it can take stresses as high as 500 cycles at 15 G's.

BAKELITE C-11 Plastic is also used for the cover, which is cemented to the case, making the cell a sealed unit with the sole exception of the vent plug. The high degree of transparency found in C-11 Plastic permits visual inspection at all stages of the battery's manufacture.

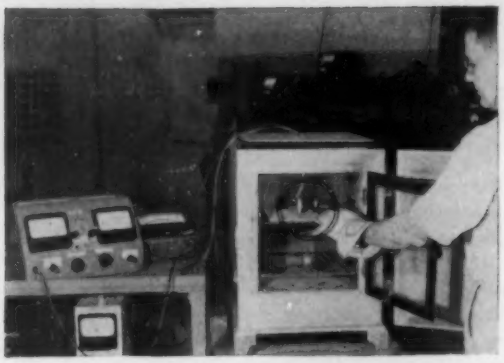
BAKELITE
BRAND
PLASTICS

PHENOLICS • STYRENES • IMPACT STYRENES
POLYETHYLENES • VINYLS • POLYESTERS
EPOXIES

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

TWENTIETH CENTURY Relay

The Potter & Brumfield

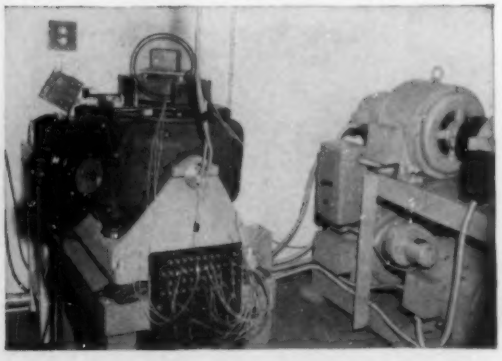


Relays operating in special constructed ovens are subject to temperatures exceeding 400° Fahrenheit. Recording instruments indicate any malfunction.

One of the reasons that keeps Potter & Brumfield Relays out in front.
The best Engineering design is not enough.
Prototypes must pass all torture qualification tests.
More important the manufactured product must meet engineering expectations. Not just now and then, but for as long as the relay is made.
That is why Potter & Brumfield relays are tortured regularly throughout production runs.

POTTER & BRUMFIELD

Frost covered sealed relays are taken from especially designed sub-zero chamber which has subjected them to continuous operation at —100° Fahrenheit.



Shaker and power supply located in soundproof room has frequency range of 0 to 2000 C.P.S. Complete with automatic servo control of acceleration and frequency cycler.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

Torture

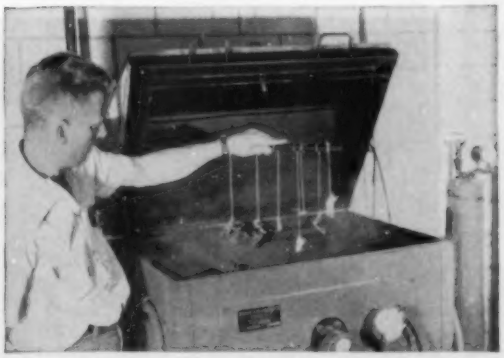
Brumfield Way

Different relay designs are subjected to torture tests in varying degrees.
Potter & Brumfield builds relays to all quality levels and at the best possible price to you.
Samples available for immediate delivery. Send your specification for recommendation and quotations.

For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Typical rugged life test using a series of 1000 watt lamps causing the relay to operate under a load 10 times more severe than normal.

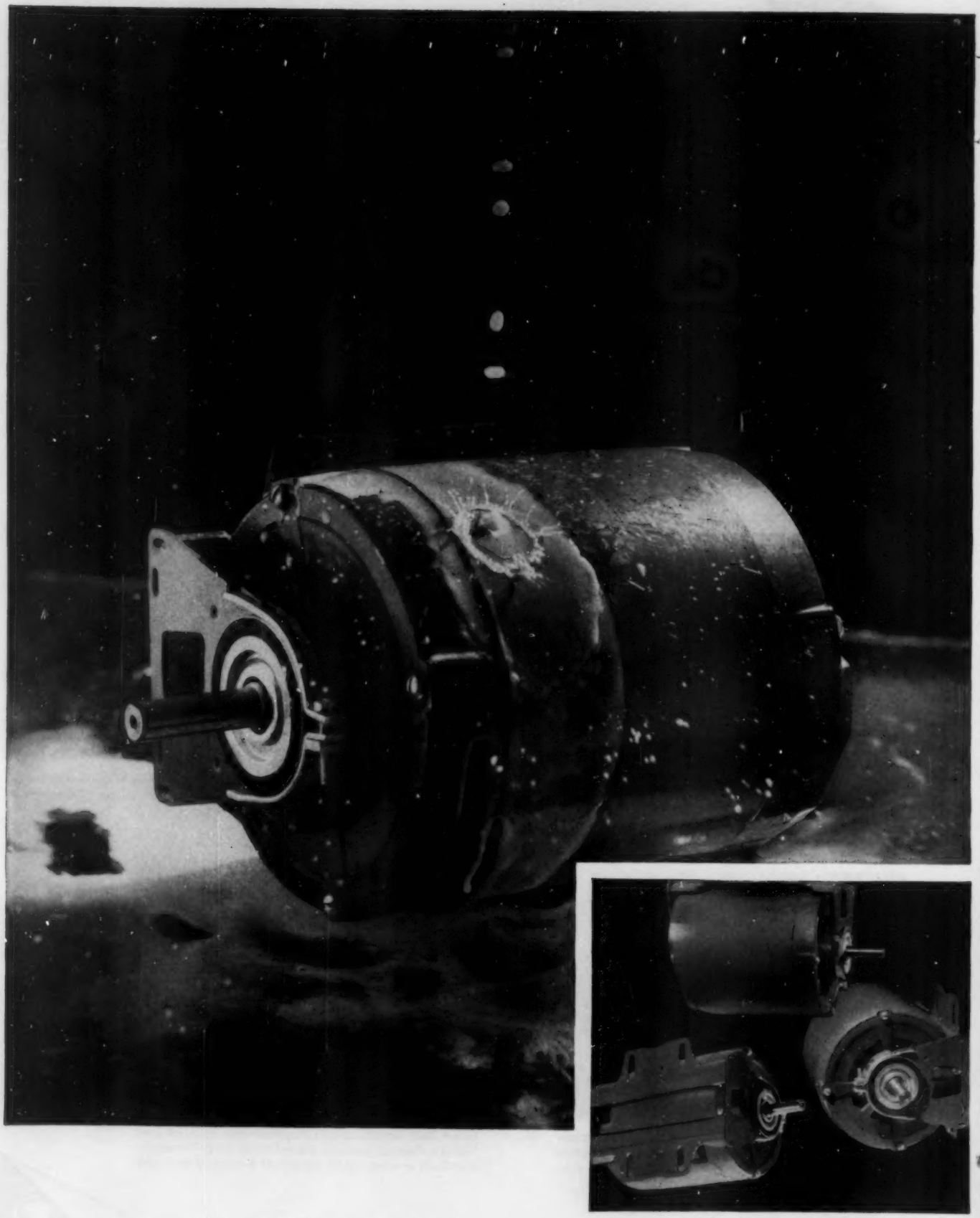
PRINCETON, INDIANA



Control of metal finishes are a must for accurate relay operation. Parts are periodically subjected to a minimum 20% salt spray to check their resistance to corrosion.

Tester built to JAN specifications provides shock of over 100 G's. Contact reactions are indicated on oscilliscopes—thyratrons or other special equipment depending on speed.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS



Fact 1 . . . no "swiss-cheese" vent holes in the solid frame to restrict mounting angles or allow liquids or dirt to damage windings.

Westinghouse Offers the Only True All-Position Mounting Motor

. . . one important FACT about the new Westinghouse 48-frame fhp motor

A solid, protective frame plus 22% more oil capacity helps make the new Westinghouse 48 frame the only true all-position mounting motor.

By using a straight-through ventilation system—which actually boosts cooling ability—the need for holes in the frame is eliminated. The rigid protection of the solid cover keeps out harmful liquids, dust and dirt, no matter what the mounting angle. Gone, too, are the bothersome whistle noises of other motor designs.

A positive oil-return lubrication system protects the new Westinghouse motor regardless of mounting position . . . your assurance of smooth performance for longer periods, even at peak loads.

Don't expect all these benefits in any other motor.

The Man With The Facts, your Westinghouse sales engineer, has all the information about this new fhp motor line. Contact him today. Or write for DB-2801. It contains complete technical data. Westinghouse Electric Corporation, Small Motor Division, Lima, Ohio.

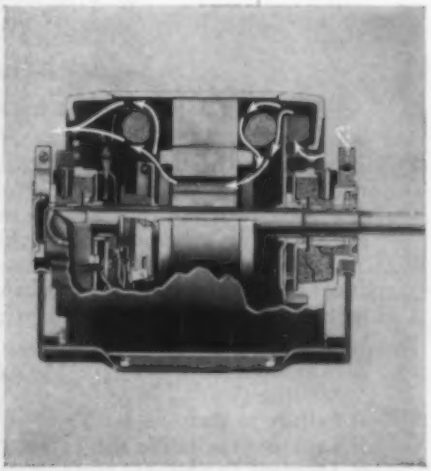
J-03020

YOU CAN BE SURE...IF IT'S

Westinghouse

Fact 2 . . . up to 40% less space needed to stock some sizes. And the motor takes less room in your product, too.

Fact 3 . . . weight savings up to 50%. Conserves mounting and housing space . . . lowers material and shipping costs.



Fact 4 . . . straight-through ventilation assures cooler operation for longer running periods, even at peak loads.

Now Get
3-PHASE
Inherent
Overheat Motor
Protection

Specify Built-in
KLIXON
PROTECTORS
in Your New Motors

★ *Eliminate Motor Burnouts*
★ *Reduce Production Down Time*
★ *Minimize Motor Repairs and Replacements*
★ *Plus maximum motor capacity under any conditions*

Klixon Protectors in your 3-phase motors, single and dual voltage, are a sure way to keep today's rising operating and replacement costs down.

Built-in as an inherent part by the motor manufacturer, the Klixon Protector saves money and reduces idle machine time by preventing the motor from burning out under the following conditions:

1. Extremely heavy overloads
2. Single phasing
3. Stalling
4. Failure to start
5. Lack of ventilation
6. Increase in ambient temperatures
7. Plugging or reversing duty

This means that you have less equipment shutdowns . . . less motor repairs and replacements.

Klixon 3-phase Motor Protectors are available in four sizes — covering a range of horsepower ratings from fractional up through 7½ hp. (600 V.).

And remember, be sure to get complete motor protection in your single phase motor, too. Specify and use motors with Klixon Inherent Protectors. The additional cost is low . . . the savings high. Write for Bulletin MOPR1 which explains inherent motor protection.

KLIXON
TRADE MARK REG. U.S. PAT. OFF.

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3211 FOREST STREET, ATTLEBORO, MASS.

ALCUPLATE®

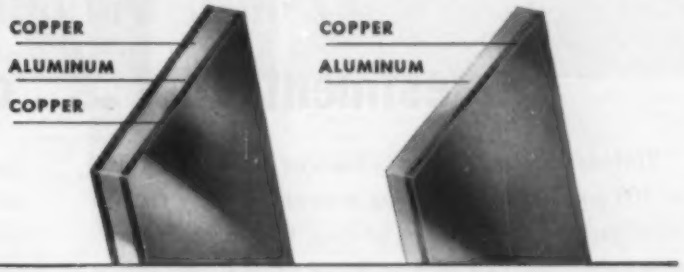
The Material of 1001 USES

Replaces Strip Copper or Brass at Savings up to 30%

Here's the Story:

Alcuplate was developed by General Plate to reduce the raw material costs for manufacturers using strip copper or brass.

A composite metal, Alcuplate is a solid layer of copper permanently bonded on one or both sides of less expensive aluminum. This combination has practically the same physical and electrical properties of copper . . . but reduces copper or brass costs by as much as 30%.



ALCUPLATE FEATURES

- Natural copper appearance
- High electrical conductivity
- Excellent heat dissipation
- Soft-soldering surfaces
- Easy fabrication
- Light weight

Here's how ALCUPLATE can be worked:

ALCUPLATE can be fabricated by stamping, drawing, spinning and forming. Its malleability permits its use in the manufacture of many parts from work-hardened rather than annealed or dead soft materials. The copper provides an ideal surface for soft-soldering operations and electroplated or other finishes.

A few typical products where ALCUPLATE is cutting fabrication costs

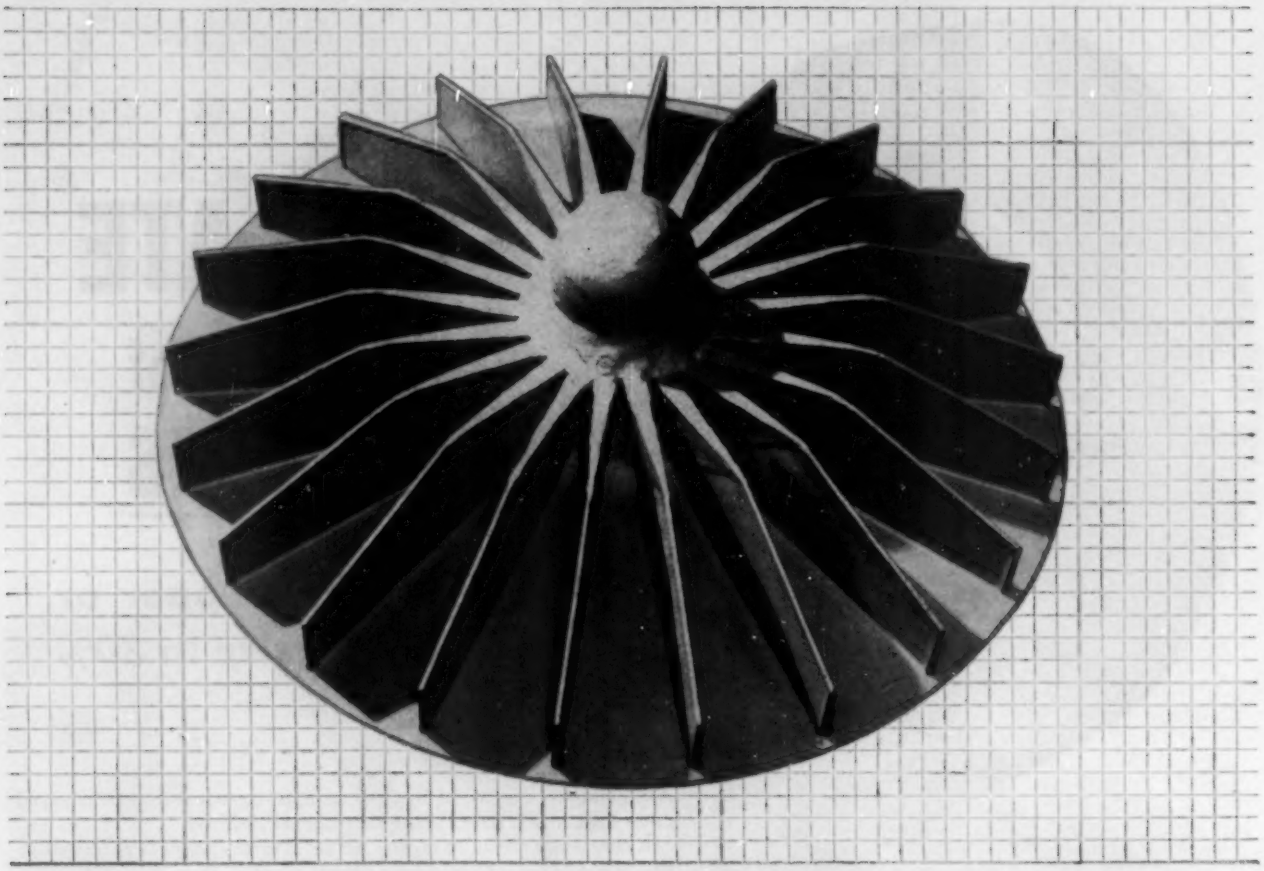
Heat transfer units • Electronic chassis and component cases • Electrical terminals Jewelry • Gift ware • Chafing dishes Water pitchers • Drain spouts

In what Sizes is ALCUPLATE Stock available?

In coils or cut lengths up to 1/16" thick by 13" wide and in a choice of thickness ratios and tempers.

For further information, write or wire

ALCUPLATE®
METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
111 FOREST ST., ATTLEBORO, MASS.



22-inch Diameter Wheels Investment Cast . . . at a 50% Saving

Turbine wheels, 22 inches in diameter and weighing close to 100 pounds, are now being mass-produced by HAYNES' precision-investment-casting process. The wheels are made of stainless steel and are used in the turbocharger section of a compressor. At one time a lengthy profile machining operation was needed to shape the intricate blades. Investment-casting eliminated this operation and cut production costs in half.

The savings realized on this wheel are typical of the many economies made possible by HAYNES' precision-investment-casting process. This modern mass-production method eliminates many machining, grinding, and assembling operations. Intricate contours, odd-shaped cavities, and thin edges can all be cast to size. Two or more parts can be designed and produced as one integral part. In most instances, an investment-cast part can be placed in operation as soon as it is delivered.

For information on how you can use HAYNES' investment-casting process to keep production costs down, write to any of the District Sales Offices listed below.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

DU PONT
REG. U.S. PAT. OFF.

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 8 — 1955

New Explosion-Fire Suppression Device Uses Bellows and Capsule of Zytel® Nylon Resin

Integral hinges of "Alathon" permit production economies

MANUFACTURERS take production short cuts with the Du Pont engineering materials—short cuts that lower costs yet often increase product efficiency. For example, consider these articles made of Du Pont "Alathon" polyethylene resin.

Use of Du Pont "Alathon" polyethylene resin permits integral molding of hinges and clasps. This saves assembly costs and increases efficiency of operation.

Thanks to the moldability of "Alathon", the lunch box and vial (see cut) are injection-molded with clasps and hinges an integral part of the product. Fewer parts are necessary and money is saved in assembly time. The lunch box clasp is strong and durable. And the attached lid on the vial can be flipped open and snapped shut with one hand.

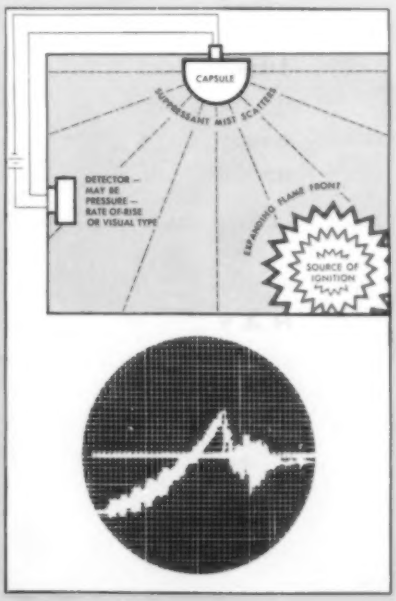
Get all the facts on "Alathon"—the techniques used to fabricate this versatile material, its properties and uses. Clip and mail the coupon on the next page for complete information.

Parts of "Zytel" can be made in many shapes; resist corrosion and breakage

Capsule and bellows of "Zytel". These parts are produced economically, resist corrosion, have remarkable strength. (Bellows is produced for Simmonds Aerocessories, Inc., Tarrytown, New York, by Plastex Process Company, Maywood, New Jersey.)

How the explosion-fire suppression system works. Pressure occurring milliseconds before an explosion extends a bellows of Du Pont "Zytel" nylon resin, which detonates a device to release the suppressant.

THE HEART of a new type explosion-and-fire suppression device is a bellows made of "Zytel" nylon resin. The device is mounted inside containers or compartments which hold combustible materials. A typical application is its use in fuel storage tanks. When the explosive fuel-air mixture is ignited, the resulting rise in pressure compresses the "Zytel" bellows. The action fires a detonator, releasing a suppressive liquid that stops the pressure rise before destruction of the tank occurs.


CAPSULE
SUPPRESSANT MIST SCATTERED
DETECTOR — MAY BE PRESSURE — RATE-OF-RISE OR VISUAL TYPE
EXPANDING FLAME FRONT
SOURCE OF IGNITION

Lightweight "Zytel" is specified for this application because its chemical resistance and flexibility supply the type of performance necessary for satisfactory operation of the bellows.

"Zytel" is also used to mold the capsule which holds the suppressive liquid. This is because the capsule must not only resist corrosion, but also be lightweight and economical to manufacture.

Du Pont "Zytel" may be just the material you need to solve a design or operating problem. For complete data on this engineering material—property tables, typical applications, production techniques—use the coupon on the back side of this page.

OVER

DU PONT
REG. U.S. PAT. OFF.

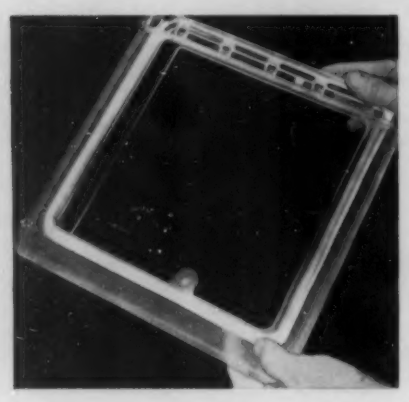
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 8 — 1955

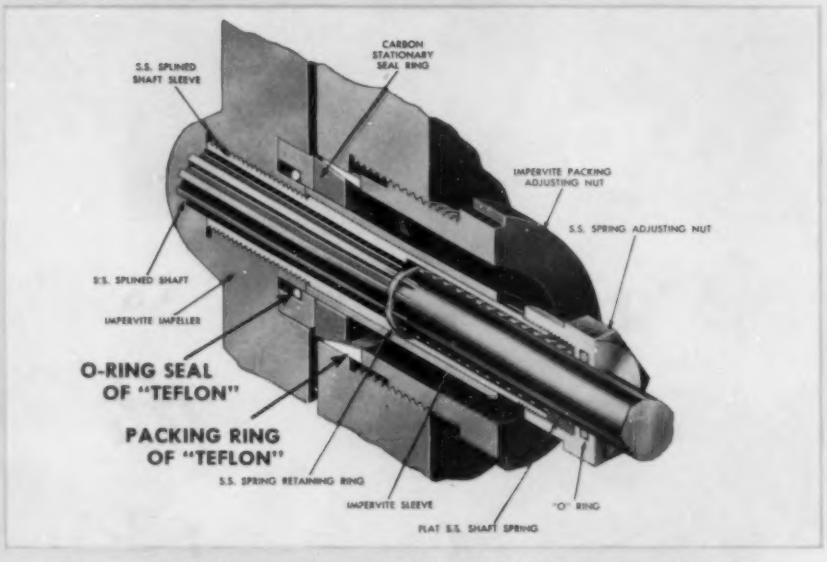
Freezer lid of transparent LUCITE® takes low temperatures, rough handling

LUCITE acrylic resin—molded as a lid for a commercial freezing cabinet—withstands low temperature and rough treatment. Used for the storage and self-service of ice cream, this freezer utilizes the



superior optical properties of "Lucite". Customers inspect the contents through the sparkling, transparent lid. "Lucite" won't corrode, resists crazing, is easy to keep clean. (Freezer lid of "Lucite" manufactured by General Products Company, Central Falls, Rhode Island for Savage Arms Corporation of Utica, New York.)

O-ring seals and packing rings of Teflon® improve design and efficiency of pump



Cutaway view of Impervite pump manufactured by Falls Industries, Inc., Solon, Ohio. Components of "Teflon" fabricated by Shamban Engineering Company, Culver City, California.

FABRICATED into O-ring seals and packing rings, Du Pont "Teflon" improves the design and efficiency of this single stage centrifugal pump. This pump can handle corrosive fluids in large volume. "Teflon" helps assure leak-proof performance. The low coefficient of friction and self-lubricating properties of the "Teflon" reduce wear of the O-ring. With O-rings and packing rings of "Teflon", a minimum of maintenance is assured. Because "Teflon" is chemically inert, corrosives can contact the packing ring to make the pump seal self-cooling.

Can the wide range of properties of "Teflon" benefit your operation? Complete property and application data are available—simply clip and mail the coupon on this page.

Investigate Du Pont engineering materials in your product development programs

ONE of the family of these versatile engineering materials is often a key factor in product improvement or new design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

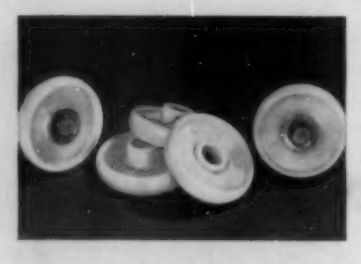
CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 1011, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____
COMPANY _____
STREET _____
CITY _____ STATE _____
TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)



These rollers of "Zytel" nylon resin are used on overhead garage doors. They move quietly and smoothly, resist abrasion, and don't rust or corrode. Little or no lubrication is required to keep these wheels running smoothly. (Rollers manufactured by Nice Ball Bearing Company, Philadelphia, Pa. Molded by Strauss Engineering Company, Philadelphia, Pa.)

The Boeing B-47—Its six jet engines, each supplying 6,000 pounds thrust, put it in the "600-mile-per-hour speed class." Operating range is more than 3000 miles.

Cold drawn Shelby Seamless Tubes provide *high strength, low weight* outrigger struts for B-47 Stratojet

The landing gear of the 100-ton B-47 Stratojet consists of dual main wheels in tandem with single outriggers attached to the inboard engine pods. The outer cylinder of each of the outrigger struts is fabricated from cold drawn USS Shelby Mechanical Tubing.

Shelby Seamless is extremely strong and shock absorbent in proportion to its weight. Thus, it is ideal for incorporation into landing gears, engine mounts, longerons, wing spars, fuselage struts, and tail assemblies. Moreover, with Shelby Seamless Tubing, *the basic shape* for myriad aircraft parts is already made—and each section of tubing is as sound as the solid steel forging from which it is pierced. Thoroughly uniform and dimensionally accurate, Shelby Seamless Tubing is easy to bend, shape, machine and weld.

Shelby Seamless is produced to exacting aircraft standards, in a wide range of diameters, wall thicknesses and steel analyses. For further information or for help in applying Shelby Seamless Mechanical Tubing to your design specifications, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

"WALLS WITHOUT WELDS," the vivid story of the manufacture of National Seamless Pipe and Tubes is available free of charge for showing to industrial groups, clubs, school groups, etc. This educational sound film in brilliant technicolor contains some of the most dramatic steel mill operations ever recorded. Write for information.

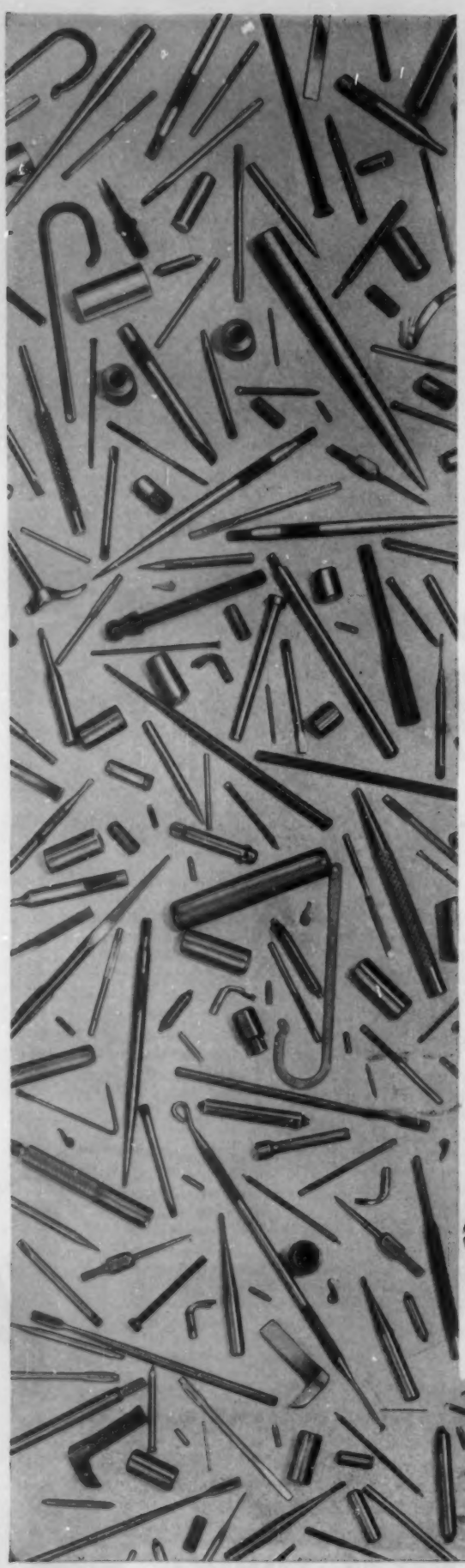
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

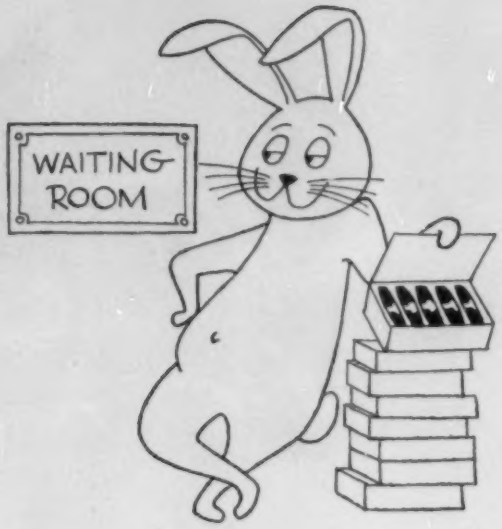
USS

SHELBY SEAMLESS MECHANICAL TUBING

WALLS WITHOUT WELDS

UNITED STATES STEEL





Rely on **TORRINGTON** *for Volume Production of small precision parts*

Volume production of small precision parts is a habit at Torrington. Each day we produce millions of pieces . . . exactly to customers' specifications of tolerance, hardness, temper and finish.

And we do it *faster, better and for less* than they can do it themselves. Send us a sample part or blueprint for a prompt quotation. And ask for our Condensed Catalog which shows hundreds of typical parts on which we can save you money.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.

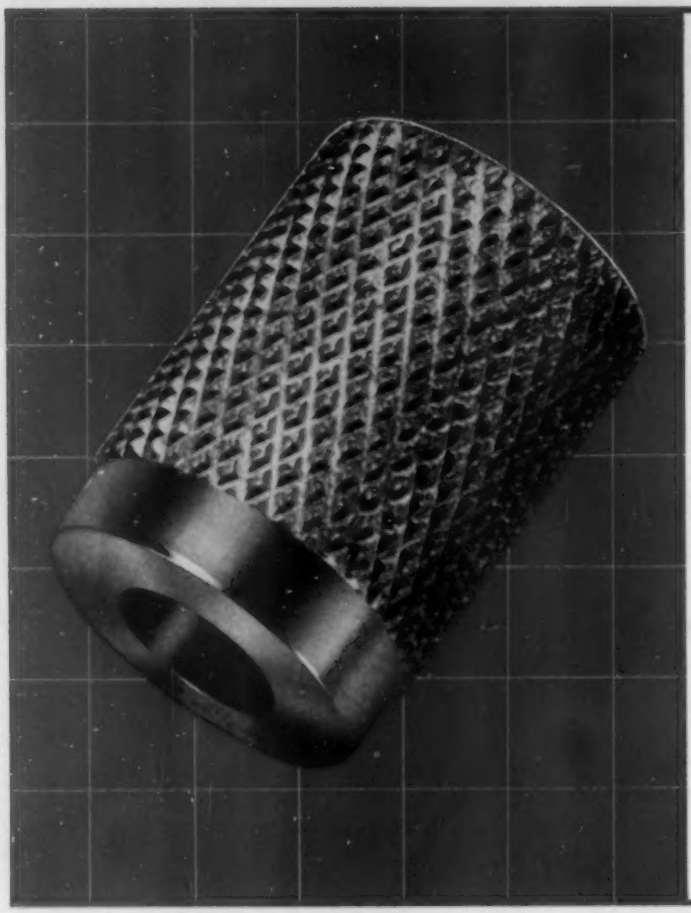
TORRINGTON *SPECIAL* **METAL PARTS**

Makers of Torrington Needle Bearings

This Ford part points to lower costs for you!

Read the full story

Aluminum part cuts costs



Screw Machine Data
Aluminum Windshield Wiper Knob Insert
Ford Motor Company

MACHINE: 5 Spindle Davenport Automatic

OPERATING DATA:
Turning—3000 R.P.M.—295 S.F.P.M.
Knurling—Diamond Knurl 3000 R.P.M.—295 S.F.P.M.

OPERATIONS:
Feed, Center, Drill, Knurl, Form, Cut-off

CYCLE TIME: 2.4 seconds

PARTS PER HOUR: 1500

EFFICIENCY: 80%

STOCK:
⅜" round, aluminum 2011-T3

OPERATOR REQUIREMENT: *Machinability*

Aluminum machined at maximum efficient cutting speed. The changeover to aluminum for this knob insert did not require any change in machining speed and setting from the previous metal used. Ford is running the part successfully at the maximum efficient speed of the automatic screw machine. And Ford found that it was not even necessary to change the angle of the form tool, which is an ordinary high speed steel tool with no chip-breaker.

The experience and engineering know-how of Ford has proved that properly designed aluminum parts can often provide substantial economies plus high quality.

For big savings and better parts...

for Ford Motor Company

THE Ford Motor Company recently changed its specifications on the Ford car windshield wiper knob insert to aluminum. This Ford part is one of several new screw machine parts now made from aluminum. They are currently studying other screw machine parts for possible conversion to aluminum.

This conversion met the requirements of management, design engineering and production groups.

MANAGEMENT REQUIREMENT: *Savings*

Change to aluminum saved approximately 24.8%. Ford management is always interested in materials or methods that will effect savings with no sacrifice in quality. In this particular case, as in others, aluminum seemed to be the logical material because it provided savings of about 24.8% per piece, including scrap loss. Also, the aluminum parts are so much lighter than the previously used metal, that Ford has realized additional savings in shipping costs.

DESIGNER REQUIREMENT: *Performance*

Aluminum met design specifications. Ford engineers selected aluminum alloy 2011-T3, ⅜″ round stock after they tested other metals and found that the aluminum knob insert would not only provide sufficient strength but would also take a slightly better knurl. The fact that aluminum satisfied performance requirements and for less money than other metals tested, was the main consideration in Ford's selection of aluminum.

ALUMINUM SCREW MACHINE STOCK OFFERS THESE BIG ADVANTAGES

You get three times as many parts from a pound of Kaiser Aluminum stock as from a pound of brass or steel. And you often get *better* parts because aluminum provides a unique combination of advantages, including lightness with strength, handsome finish, corrosion resistance, good heat and electrical conductivity.

For more information or assistance, look for our local number in the classified telephone directory under the heading "Aluminum". Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, California.

think of **Kaiser Aluminum**

For more information on aluminum screw machine stock contact one of these sales offices

AKRON, Ohio
Room 1422, First National Tower
Phone: Blackstone 3-6105

ATLANTA, Georgia
Room 1522 Fulton Nat'l Bank Bldg.,
55 Marietta St., N.W.
Phone: Cypress 8626

BALTIMORE, Maryland
5017 York Rd.
Phone: Tuxedo 9-7287

BIRMINGHAM, Alabama
1408 Brown-Marx Bldg., 1st Ave. & 20th St.
Phone: 7-5196, 5197

BOSTON, Massachusetts
Rooms 735-736, Statler Office Bldg.,
20 Providence St.
Phone: Hancock 6-7255

BUFFALO, New York
Room 211, The Hodge Bldg.,
360 Delaware Ave.
Phone: Mohawk 0945

CHARLOTTE, North Carolina
Room 906, Liberty Life Bldg.,112 S. Tryon St.
Phone: Franklin 5-7358

CHICAGO, Illinois
360 N. Michigan Ave.
Phone: Dearborn 2-5080

CINCINNATI, Ohio
2330 Victory Parkway
Phone: Capitol 1-5550

CLEVELAND, Ohio
2002 NBC Bldg., 815 Superior Ave.
Phone: Superior 1-3000

COLUMBUS, Ohio
1200 Beggs Bldg., 21 E. State St.
Phone: Capital 1-5539

DALLAS, Texas
Room 225, Mercantile Commerce Bldg.,
1810 Commerce St.
Phone: Prospect 7-1501

DAVENPORT, Iowa
Davenport Bank Bldg., 220 Main St.
Phone: 3-8005

DAYTON, Ohio
207 Realty Bldg., 132 N. Main St.
Phone: Michigan 0317

DENVER, Colorado
Suite 480, Denver Club Bldg., 518-17th St.
Phone: Alpine 5-3459

DETROIT, Michigan
1414 Fisher Bldg.
Phone Trinity 3-8000

EVANSVILLE, Indiana
Room 601-602, Citizens Nat'l Bank Bldg.
Phone: 3-6281

GRAND RAPIDS, Michigan
534 Keeler Bldg., Division Ave. and
Fountain St., N.E.
Phone: Glendale 6-8601

HARTFORD, Connecticut
Hartford Federal Savings & Loan Bldg.,
1107 New Brittain Ave., Elmwood, Conn.
Phone: Adams 3-9631

HOUSTON, Texas
Room 701, Merchants & Mfrs. Bldg.,
1 Main St.
Phone: Capitol 8-0418

INDIANAPOLIS, Indiana
Suite 935, Architects & Builders Bldg.,
333 N. Pennsylvania St.
Phone: Melrose 4-8311

KANSAS CITY, Missouri
Room 214, Fairfax Bldg., 101 W. 11th St.
Phone: Harrison 0829, 0830, 0831

LOS ANGELES, California
Statler Center, 900 Wilshire Blvd.
Phone: Madison 6-4801

LOUISVILLE, Kentucky
Room 315, 310 W. Liberty St. Bldg.
Phone: Jackson 7193, 7194

MIAMI, Florida
Room 204, Dade Federal Bldg.,
1400 Northwest 36th St.
Phone: Miami 65-2494

MILWAUKEE, Wisconsin
Room 1121, 710 N. Plankinton Ave.
Phone: Broadway 2-8005

MINNEAPOLIS, Minnesota
1540 Rand Tower
Phone: Bridgeport 8711

NEWARK, New Jersey
Room 3304, Nat'l Newark Bldg.,
744 Broad St.
Phone: Market 4-6116

NEW ORLEANS, Louisiana
331 International Trade Mart, 124 Camp St.
Phone: Tulane 4678

NEW YORK, New York
Rooms 3408-3419, Lincoln Bldg.,
60 E. 42nd St.
Phone: Murray Hill 7-8580

OAKLAND, California
Suite 1515, Latham Sq. Bldg., 508-16th St.
Phone: Twinoaks 3-4600

PHILADELPHIA, Pennsylvania
Room 402, 226 S. 16th St.
Phone: Kingsley 6-1020

PITTSBURGH, Pennsylvania
Room 552, Gateway Center Bldg.,
2, East Wing, 140 Stanwix St.
Phone: Express 1-0280

PORTLAND, Oregon
805 Terminal Sales Bldg.,
1220 S.W. Morrison St.
Phone: Capitol 8-2383

SOUTH BEND, Indiana
JMS Bldg., 108 N. Main
Phone: Central 3-9311

ST. LOUIS, Missouri
4 Jaccard Bldg., 7 N. Brentwood Blvd.
Phone: Volunteer 3-1100, 3-1101, 3-1102

SEATTLE, Washington
308 Hoge Bldg.
Phone: Main 1001

SPOKANE, Washington
708 Spokane & Eastern Bank Bldg.,
West 601 Riverside
Phone: Temple 2704

SYRACUSE, New York
615 West Genesse St.
Phone: Syracuse 74-6825

TOLEDO, Ohio
304 Bennett Bldg., 1806 Madison Ave.
Phone: Fulton 6246

TULSA, Oklahoma
507 Tri-State Insurance Bldg., 619 S. Main St.
Phone: Cherry 2-9261

WICHITA, Kansas
213 S. Main St.
Phone: Forest 3-5253

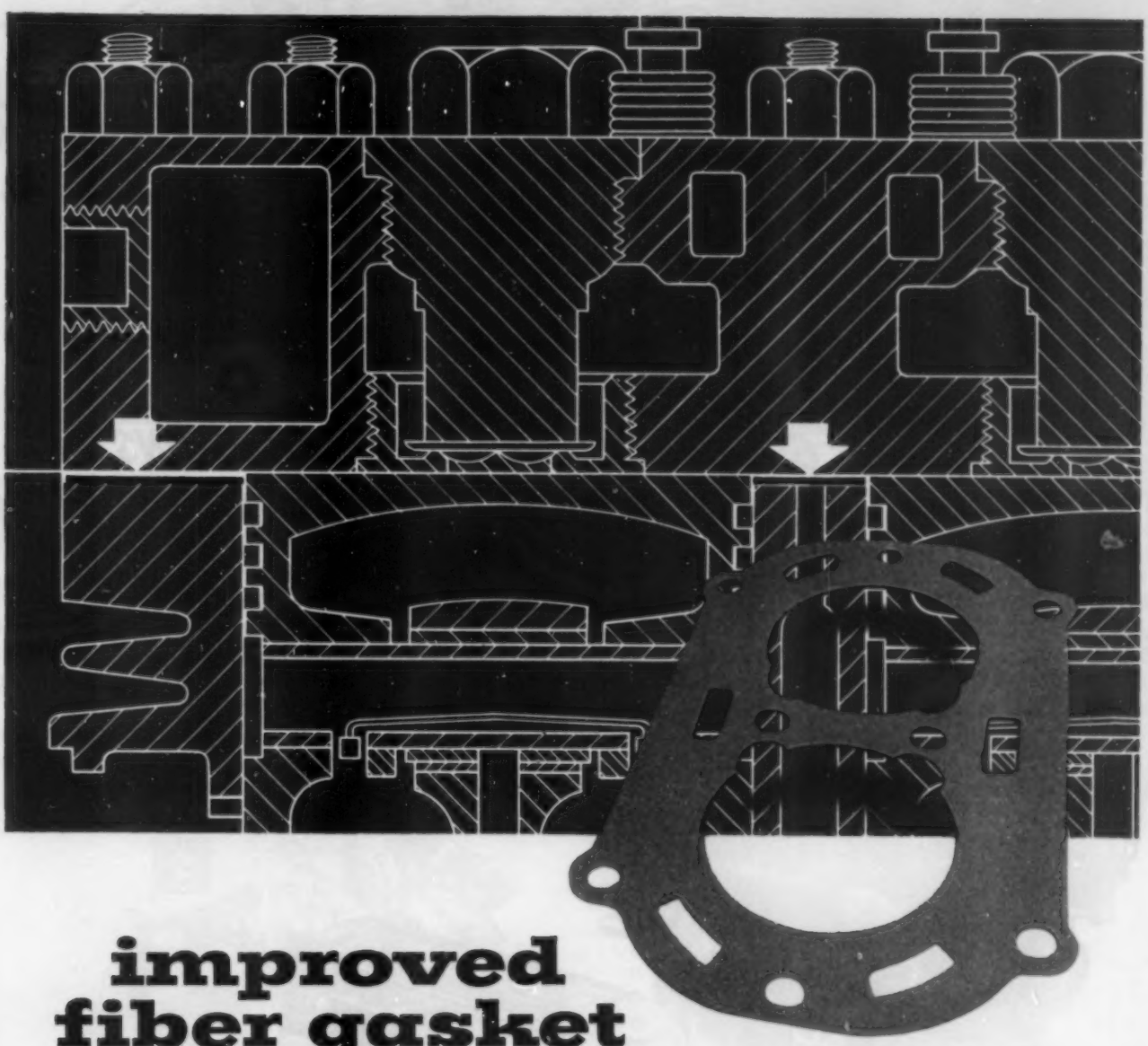
YORK, Pennsylvania
1771 E. Market St.
Phone: York 2-6987

YOUNGSTOWN, Ohio
Room 811, Union Nat'l Bank Bldg.
Phone: Riverside 3-4188

EXPORT OFFICE:
Kaiser Bldg., 1924 Broadway,
Oakland 12, California
Phone: Twinoaks 3-4600

WASHINGTON OFFICE:
1625 Eye St., Washington, D. C.
Phone: Sterling 3-1555

Kaiser Aluminum



improved fiber gasket

withstands heat, solves maintenance problem

The non-metallic cylinder-head gaskets used by a manufacturer of air compressors crumbled to pieces whenever a unit was disassembled for maintenance. Operating temperatures up to 250° F. charred these gaskets and made flanges hard to clean.

Later, Armstrong CN-705 Accopac® was used in place of the original material. It withstood the high operating temperatures and gave long, dependable service without replacement.

Accopac is made by a patented, beater-saturation process which blends fiber and cork with a non-volatile, non-extractable latex binder. The resultant sheets are uniform, unusually compressible, and impervious at bolting pressures as low as 800 psi.

Accopac is widely used in pumps, aircraft and automotive devices, household appliances, and many other applications.

FREE 24-PAGE MANUAL—For data on Accopac and facts on Armstrong synthetic rubber, cork composition, and cork-and-rubber, look for "Armstrong Gasket Materials" in Sweet's product design file . . . or write Armstrong Cork Co., Industrial Div., 7011 Irvin St., Lancaster, Pa. **Be sure to specify Armstrong materials when you order from your local gasket fabricator.**

Armstrong Accopac

. . . used wherever performance counts

DESIGN SOLUTIONS with G-E

G.E. OFFERS SPECIAL SOLUTIONS FOR YOUR SPECIAL ELECTRIC-DRIVE PROBLEMS

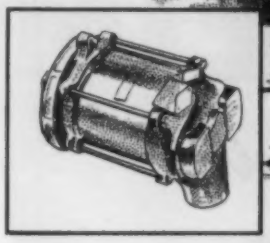
DID YOU KNOW GENERAL ELECTRIC'S SPECIALTY COMPONENT MOTOR DEPARTMENT DESIGNS AND BUILDS THOUSANDS OF SPECIAL MOTORS AND GENERATORS TO SOLVE SPECIAL ELECTRIC-DRIVE PROBLEMS ON YOUR PRODUCTS? THIS DEPARTMENT'S COMPLETE SPECIALTY-MOTOR LINE INCLUDES A WIDE VARIETY OF SMALL AC AND DC MOTORS AND GENERATORS, ALTERNATORS, AMPLIDYNES, TACH GENERATORS, DYNAMOTORS, AND UNIVERSAL MOTORS. AND THE G-E MOTOR ENGINEERS READY TO WORK WITH YOU WILL EXPERTLY MODIFY BASIC DESIGNS TO PROVIDE THE CHARACTERISTICS, ENCLOSURE, SIZE AND SHAPE, AND SPECIAL ACCESSORIES **YOU** REQUIRE FOR **YOUR PRODUCTS.**

WHERE CAN YOU USE THIS NEW, GEARLESS LOW-SPEED AC MOTOR?

ONLY G.E. OFFERS THIS SYNCHRONOUS INDUCTOR MOTOR—OPERATING AT LOW SPEED ON 115 OR 230-VOLT AC POWER. LIMITLESS USES INCLUDE MOTOR-OPERATED VALVES, MACHINE TOOLS, REMOTE-CONTROL SYSTEMS. RAPID ACCELERATION, DECELERATION, REVERSING. SEALED-IN LUBRICATION FOR LONG LIFE.

TWO MODELS: 75 RPM, 75 OZ-IN.; 100 RPM, 2 OZ-IN.

specialty motors



SPECIAL G-E ALTERNATOR PUTS PINEAPPLE HARVESTING ON A 24-HOUR BASIS

... SPECIALLY DESIGNED G-E ALTERNATORS—RATED FOR CONTINUOUS DUTY IN AMBIENT TEMPERATURES UP TO 120°F—NOW PROVIDE POWER FOR FLOODLIGHTS AND SMALL HAND TOOLS ON HUGE PINEAPPLE HARVESTING MACHINES. THIS PERMITS HAWAII'S PINEAPPLE GROWERS TO OPERATE ROUND-THE-CLOCK TO GATHER THE FRUIT AT THE PEAK OF PERFECTION. **G-E APPLICATION "KNOW-HOW" PLUS QUALITY DESIGN AND MANUFACTURE** ASSURE LOW MAINTENANCE, MINIMIZE DOWNTIME.

AVAILABLE: COMPLETE ENGINEERING ASSISTANCE FOR YOU!

HERE'S THE SPECIAL ATTENTION YOUR PROBLEMS GET AT G.E.:
1. YOUR LOCAL G-E APPARATUS SALES ENGINEER LEARNS ALL ABOUT YOUR NEEDS FROM YOUR DESIGN PEOPLE.
2. HE CALLS IN A TEAM OF FACTORY ENGINEERS WITH YEARS OF MOTOR APPLICATION EXPERIENCE. 3. AT THEIR DISPOSAL ARE G.E.'S COMPLETE DEVELOPMENT AND TESTING FACILITIES. 4. IN SHORT ORDER, A SAMPLE G-E MOTOR IS READY FOR TESTING ON YOUR PRODUCT.

FOR THIS COMPLETE HELP, CONTACT YOUR NEARBY G-E APPARATUS SALES OFFICE, TODAY. OR IF YOU PREFER, **WRITE** GIVING FULL DETAILS TO SECT. 704-58, GENERAL ELECTRIC CO., SCHENECTADY 5, N.Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

automation *with* HEIM *Unibal*

America's greatest participant sport, tenpin bowling, is played by approximately 20 million Americans on more than 60,000 alleys. The AMF Automatic Pinspotter represents a piece of equipment which all bowling for years has hoped would eventually be developed. It is a fully automatic unit for setting tenpins, returning the ball, accomplishing all pit services now done by hand, but with greater efficiency. More than 5,000 Pinspotters are now in operation.

In the AMF Pinspotter, Heim Unibal Rod Ends are used on the Pantograph bars which guide and stabilize the spotting table during its cycle of up and down drive. They are also used to drive the sweep mechanism and on the sweep carriage. The major application of the Heim Rod Ends on the Pinspotter is where it is employed in a shock-absorbing link arrangement to raise and lower the table. Here it is subjected to lifting a load of approximately 350 pounds.

THE ABILITY OF THIS JOINT TO COMPENSATE FOR MISALIGNMENT AND MAINTAIN FREEDOM OF ROTATION MAKES ITS USE ON THE PINSPOTTER VERY SATISFACTORY

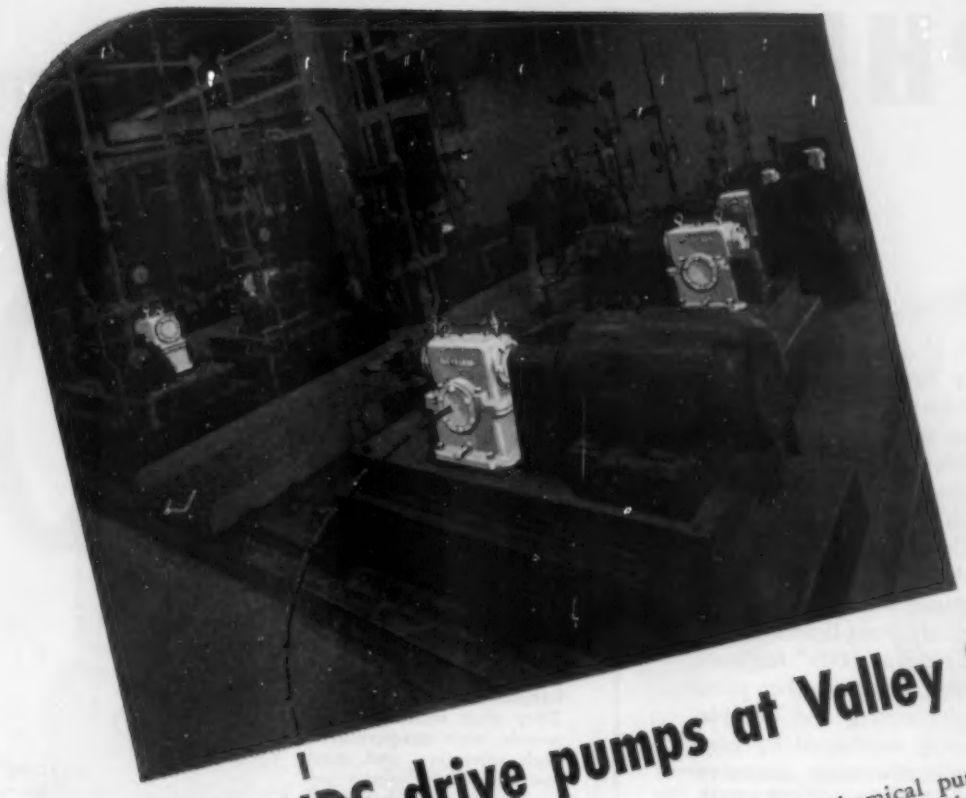
The HEIM Unibal is the original Spherical Bearing developed, engineered, and manufactured by The Heim Company for nearly fifteen years. It consists of a single ball (instead of a single or double row of balls) rotating in an outer member, and supported by bronze bearing inserts which act as the race.

For center shaft or end support, the outer member is cylindrical in shape and made in a wide range of sizes. As a rod end for the transmission of power or motion at varying angles, the outer member is made with lubrication groove, in either male or female design, and with lubricator fitting if required.

SEE THE NEW HEIM CATALOG FOR COMPLETE LIST OF SIZES

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT



A chemical pump room of 80 million dollar Valley Steam Plant of the Los Angeles Department of Water and Power.

10 CLEVELANDS drive pumps at Valley Steam plant

PLAYING an important role in the chemical pump room of the Valley Steam plant are 10 Cleveland Worm Gear Speed Reducers. In this capacity, these Clevelands provide Milton Roy pumps with the variation of stroking speeds necessary to insure accurate control of proportioning and volume of chemicals used to treat the water to prevent scale and corrosion.

Notice how Cleveland worm gear units take up a minimum of space. And, power is transmitted with a smooth, uniform torque flow. Case-hardened steel worms mesh with nickel-bronze gears for long, hard, dependable service without appreciable wear.

You'll find Clevelands throughout the chemical and allied industries—driving pumps, agitators, mixers—in fact, every kind of equipment for which a right-angle drive is needed.

If yours is a power transmission problem, you can get help by writing for Catalog 400. It gives the full story. The Cleveland Worm and Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication.
In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

GRAPHITAR® . . . the versatile

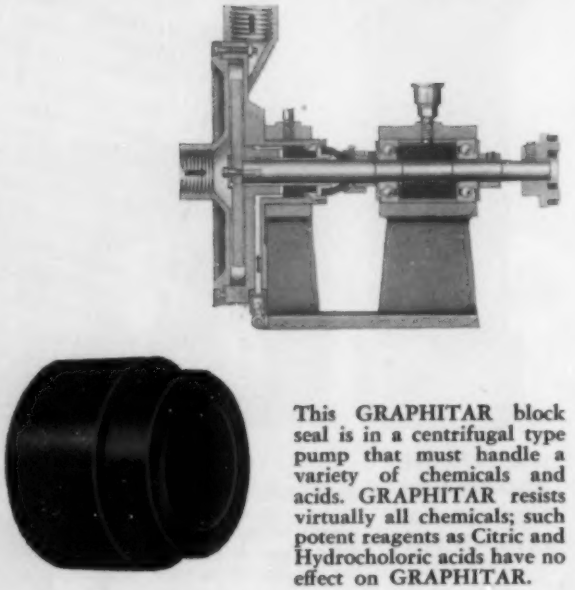
(CARBON-GRAPHITE)

insuring the performance

There are literally hundreds of difficult applications where the only completely successful material is GRAPHITAR. It can be used where water and steam are present . . . in fact, where *only* water and steam are present . . . because it does not need oil lubrication. It can be used where the temperatures are those of a toaster or the pressures those of a pump. GRAPHITAR is a versatile engineering material produced from carbon-graphite powders, compacted under terrific pressure and fused at heats near 4500° F. It can be formed in relatively complicated shapes and ground to tolerances as close as .0005" for seals, bearings, vanes, piston liners and many other parts. GRAPHITAR is lightweight, strong and durable, chemically inert, and virtually unaffected by high speeds, high pressures, or temperature extremes. Write today for our illustrated 64-page GRAPHITAR catalog.

These GRAPHITAR bearings are part of the hermetically sealed pumps in our new atomic-powered submarine NAUTILUS. They must withstand high speeds, high temperatures, high pressures, and must operate for indefinite periods of time without maintenance and with radioactive hot water as the only lubricant.

GRAPHITAR is a standard part of this latest type automotive water pump seal. This seal will not leak hot water, cold water, or any type of antifreeze; the wear resistance and chemical resistance of GRAPHITAR insure a seal that will last for the life of the car.



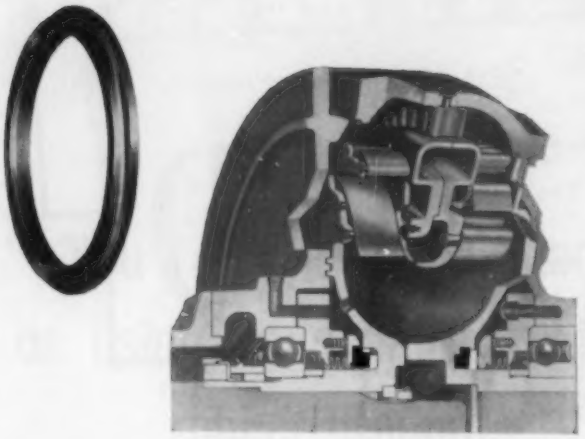
This GRAPHITAR block seal is in a centrifugal type pump that must handle a variety of chemicals and acids. GRAPHITAR resists virtually all chemicals; such potent reagents as Citric and Hydrocholoric acids have no effect on GRAPHITAR.

OUR 101ST YEAR

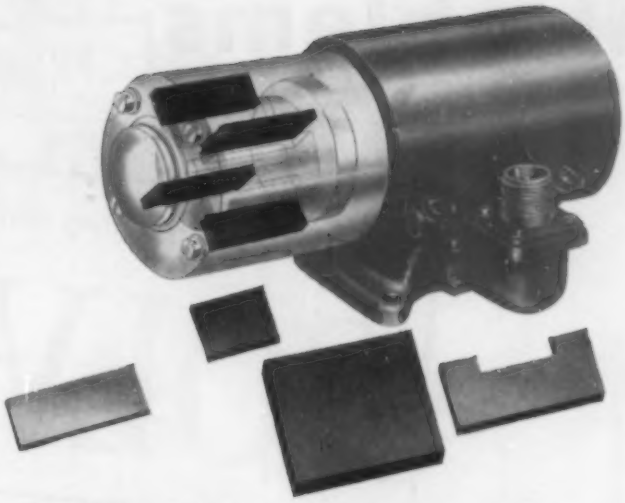
THE UNITED STATES

material that is

of hundreds of products



Operating at temperatures up to 350° and 400° F., under pressures of 100 psi and rotating at 1000 feet per minute, GRAPHITAR seals in this industrial torque converter hold a static head and will not gall or leak hot oil. The lapped flat surfaces do not warp or distort.



Rotary pumps, compressors, air motors, vacuum pumps and similar machines equipped with GRAPHITAR vanes function efficiently, give long service, and require little or no maintenance. 25,000,000 of these vanes are now operating in automobiles, in aircraft, in farm equipment, and in household appliances.

These mechanical seals rotate with the shafts of such units as rotary pumps, autoclaves, blowers, etc., to provide a pressure-tight rotary seal. The GRAPHITAR gland insert is ideally suited for this use because it is self-lubricating, chemically inert, and highly resistant to wear.

This pump is essentially an electric motor built around a rotor supported by two GRAPHITAR bearings. It can pump almost any liquid, and the liquid itself is the only lubricant for the GRAPHITAR bearings. The pump is leakproof and needs no oiling.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

Your Design Problems

PROBLEM: Lay Out Piping Most Economically

PROBLEM: Adapt One Pump to All Units

PROBLEM: Stocking Too Many Models

PROBLEM: Mounting Method Restrictions

SOLVED

by ALLIS-CHALMERS Pump Specialists

Your Allis-Chalmers representative is an experienced, highly qualified pump specialist who will give you full cooperation — from planning to purchasing to production. He will help you select exactly the right pump to fit your requirements from Allis-Chalmers wide range of types and sizes.

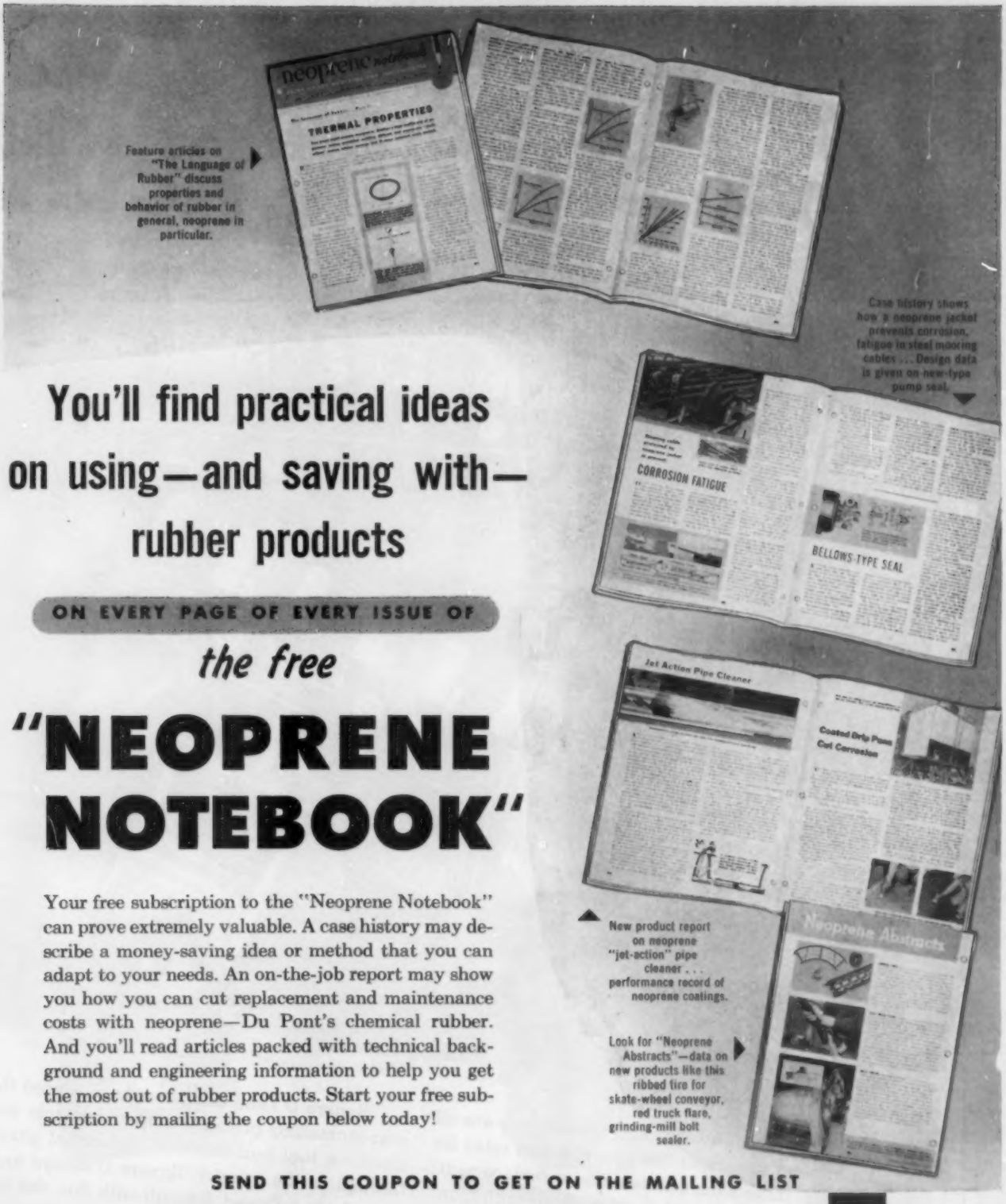
The A-C expert will gladly give you as much help as you need in engineering your setup. He may be able to make valuable suggestions which will result in savings of time, money, effort, or in a better product.

Once your equipment goes into the field, Allis-Chalmers nationwide network of Certified Service Shops assures fast service wherever the user may be, relieving you of part of your service problem.

Allis-Chalmers OEM pumps are available from strategic stocking points all over the country. Contact your A-C District Office for details on how to expedite pump selection and ordering, or write Allis-Chalmers, Milwaukee 1, Wis., for more information.

A 4753

ALLIS-CHALMERS


Feature articles on "The Language of Rubber" discuss properties and behavior of rubber in general, neoprene in particular.
neoprene notebook
THERMAL PROPERTIES
Case history shows how a neoprene jacket prevents corrosion fatigue in steel mooring cables . . . Design data is given on new-type pump seal.
CORROSION FATIGUE
BELLOWS-TYPE SEAL
Jet Action Pipe Cleaner
Coated Dirty Pipes Cut Corrosion
New product report on neoprene "jet-action" pipe cleaner . . . performance record of neoprene coatings.
Look for "Neoprene Abstracts"—data on new products like this ribbed tire for skate-wheel conveyor, red truck flare, grinding-mill bolt sealer.
Neoprene Abstracts

You'll find practical ideas on using—and saving with—rubber products

ON EVERY PAGE OF EVERY ISSUE OF

the free

"NEOPRENE NOTEBOOK"

Your free subscription to the "Neoprene Notebook" can prove extremely valuable. A case history may describe a money-saving idea or method that you can adapt to your needs. An on-the-job report may show you how you can cut replacement and maintenance costs with neoprene—Du Pont's chemical rubber. And you'll read articles packed with technical background and engineering information to help you get the most out of rubber products. Start your free subscription by mailing the coupon below today!

SEND THIS COUPON TO GET ON THE MAILING LIST

NEOPRENE

The rubber made by Du Pont since 1932

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, PE-11, Wilmington 98, Del.
Please send me the free "Neoprene Notebook" regularly.

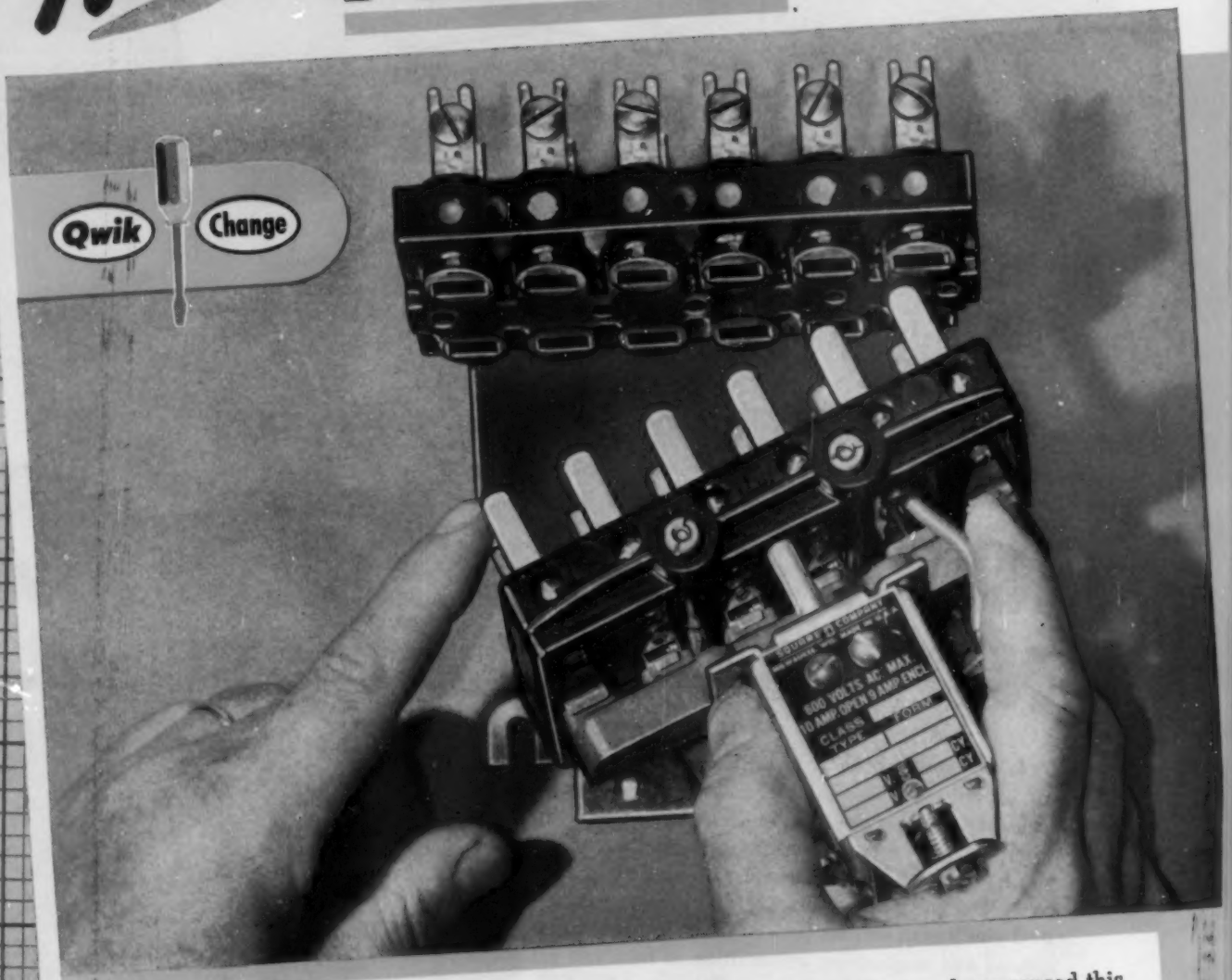
Name _____ *Position* _____

Firm _____

Address _____

City _____ *State* _____

Now PLUG-IN RELAY



• A screwdriver and five seconds are all you need to remove this new **PLUG-IN** relay for normal inspection, maintenance or replacement! That's big news in these days of "pushbutton" operations when even a few minutes of down-time can mean thousands of production dollars down the drain.

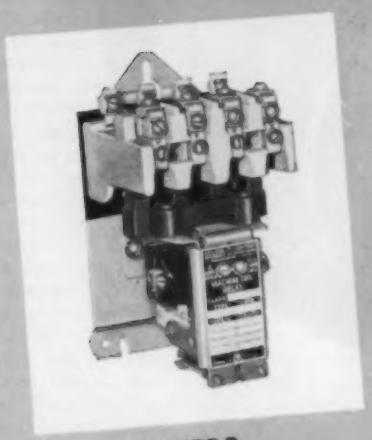
Square D Field Engineers have sensed this ever-increasing problem in their contacts with machine tool builders and industrial plants throughout the country. Square D design engineers have followed through with this, the first **plug-in** relay built specifically for machine tool use. Another example of design leadership!

Write **for Bulletin 8501**
Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin

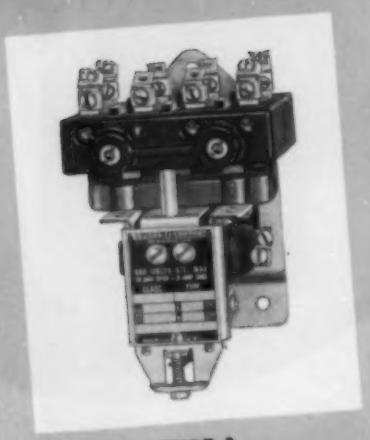
SQUARE D COMPANY

for Machine Tool Service!

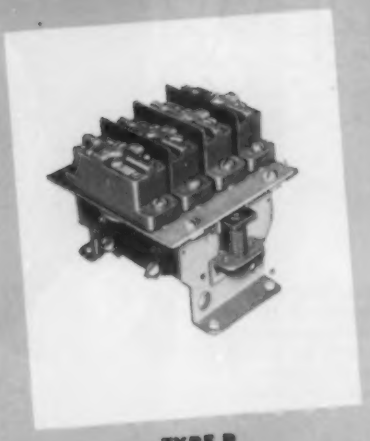
HERE ARE THE OTHER MEMBERS OF SQUARE D's RELAY TEAM



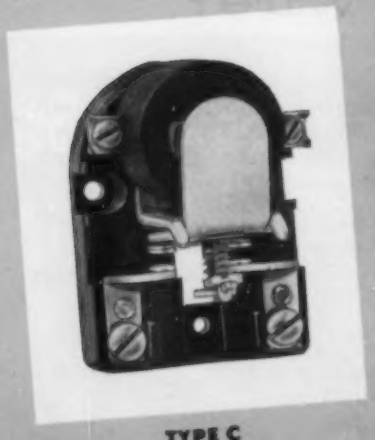
TYPE B
(15 Amperes, 600 Volts) Heavy-duty construction with hardened parts for very severe machine tool service



TYPE A
(10 Amperes, 600 Volts) Designed for general-purpose applications involving normal operations

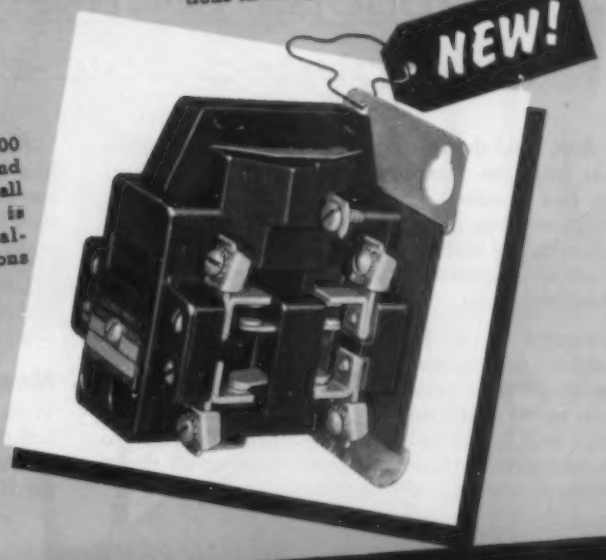


TYPE P
(Rated 10 Amperes, 600 Volts) Totally-enclosed contacts make this type especially suitable for operations in dusty or linty locations



TYPE C
Used as auxiliary devices for controlling small, single phase motors or other light loads

TYPE D
(Rated 10 Amperes, 600 Volts) This new and most compact of all Square D relays is ideal for general-purpose applications involving very limited space



ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

A SYLVANIA SPECIALTY **CUSTOM-PLATED WIRE**

Special continuous plating process assures uniformity of wire composition in plating ranges from "flash" to 20% by weight. Composition can be tailored to give you the exact wire properties you want.

What special properties do you want in a plated cold-drawn wire?

CAN a fine, cold-drawn wire with special properties help you improve product design or manufacture? Sylvania has "made-to-order" facilities to meet your exact requirements. Whatever your interests in wire, for mechanical or electrical use, Sylvania is equipped to produce a composite wire tailored to your product or production needs.

Your composite can be plated or clad in numerous combinations of materials. A few of the composites being produced on a custom basis are: nickel on brass; copper on steel; silver on copper; and nickel on steel. Your wire can be plated in weights from "flash" to 20%: mechanized equipment keeps unit costs down and insures uniformity of composition.

Made-to-order composites is just one reason Sylvania has become a major supplier of fine wires. You can specify diameters from .250 to .002. Flattened wire is a Sylvania specialty, too, and can be supplied ⅛-inch wide or less in many cross-sectional designs.

Consult Sylvania on your next special-wire problem —whatever the nature of your product.

New...
Wire Facilities Brochure—gives full details on Sylvania's wire and ribbon production story. Write for it. Address Dept. L33S

PARTS DIVISION metal stamping · special wire · molded plastics · precision dies

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

Now in a BIG WAY

REVERE ALUMINUM

To manufacturers whose building products are competing for a place in the more than a million homes, farm buildings, schools, apartments, office and public buildings that are going up this year, Revere Aluminum offers attractive new opportunities.

It offers the ultimate user the advantage of strong, light-weight products that are high in serviceability and attractiveness and low in their need of upkeep. It offers the manufacturer almost unlimited scope in design plus the competitive feature of ready workability for low-cost and fast production.

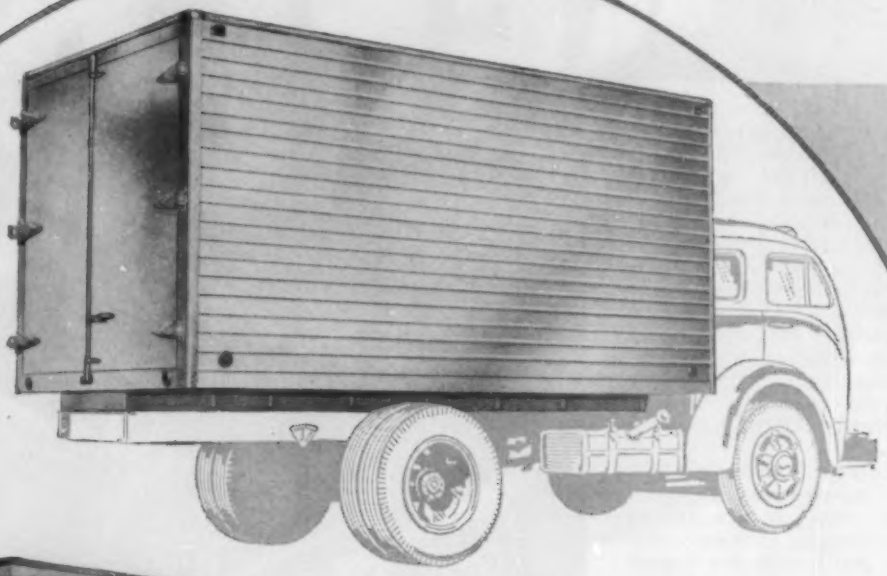
Revere Aluminum is available in the forms of tube, extruded products, coiled and flat sheet, circles, blanks, awning stock, bus bar, forgings, Lockseam tube, rolled shapes, and foil. Revere Copper and Brass Incorporated, Founded by Paul Revere in 1801, 230 Park Avenue, New York 17, N. Y.

REVERE KNOWS ITS A-B-C's

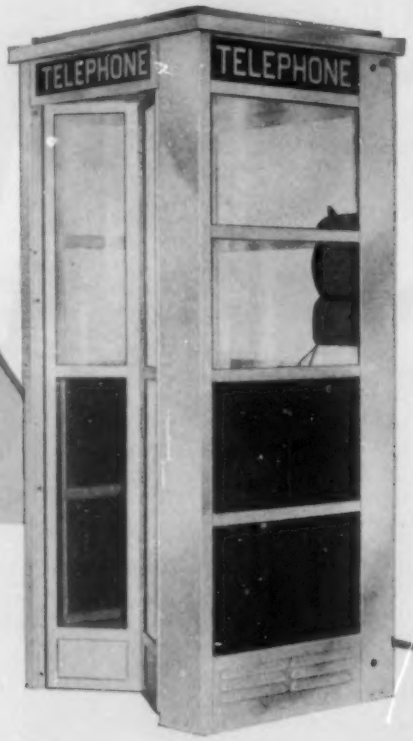
ALUMINUM BRASS COPPER

Here's why you can solve design and

ALUMINUM



Strong, lightweight, rustproof aluminum truck bodies like this are produced by Reynolds and furnished to a leading truck-trailer manufacturer in subassemblies.



Complete assemblies (or subassemblies) like this aluminum telephone booth are economically and efficiently mass-produced by Reynolds Aluminum Fabricating Service.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING • BRAZING

production problems with

ASSEMBLIES

from REYNOLDS

This gang drill is being used to fabricate truck body subassemblies. Reynolds offers over 200 major pieces of production equipment in two plants alone.

Aluminum truck bodies move along rapidly on this Reynolds assembly line. The manufacturer receives them in easy-to-handle subassemblies.

Another assembly line photo taken in one of the more than 30 Reynolds plants in 18 states. Here work is in progress on aluminum telephone booths.

Your most ambitious aluminum designs can almost always be put into action by Reynolds Aluminum Fabricating Service because Reynolds has the experience with aluminum and the facilities to produce complete assemblies and subassemblies quickly, efficiently and economically.

In addition to permitting greater design freedom, Reynolds tremendous fabricating facilities also help solve problems of lack of machine capacity, space, capital for raw material inventory and other problems that can restrict design freedom and plant output.

These Reynolds facilities, that make possible production of aluminum truck bodies, telephone booths and other major assemblies, include complete departments for embossing, stamping, drawing, riveting, forming, brazing, roll shaping, tube bending, welding, finishing and other operations using aluminum.

Remember, too, Reynolds quality control from mine to finished product and Reynolds experienced design and engineering service go hand in hand with these facilities to assure you the most from your designs.

For full details on aluminum assemblies, subassemblies, semi-fabricated and finished parts, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.*

FREE:

Write for your copy of the 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.

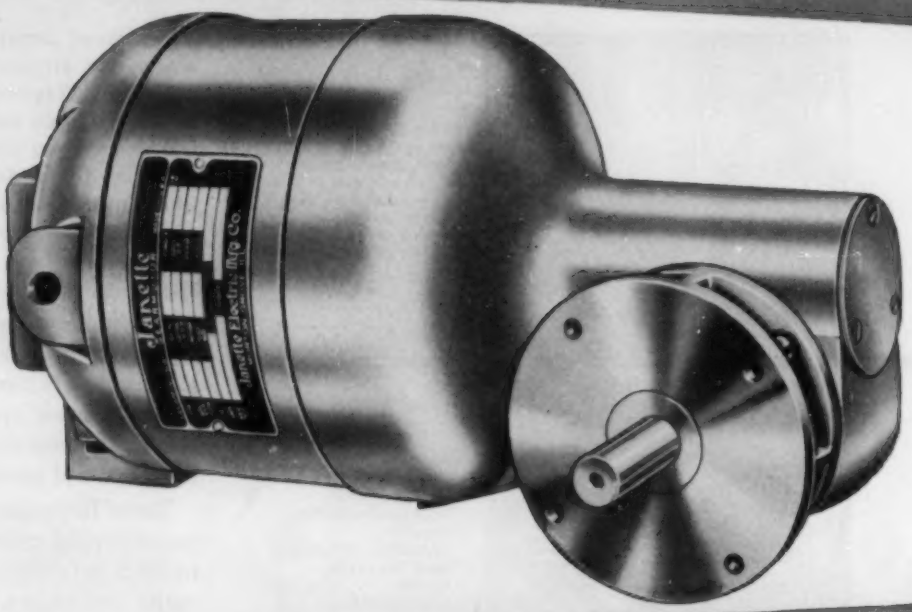
Watch "Frontier" on NBC-TV
Sunday evenings

FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • FINISHING • IMPACT EXTRUDING

"THE RIGHT SPEED...THE RIGHT POWER"

Janette GEAR



"ALL IN ONE—MADE BY ONE"

Janette Gear Motors are single integral units . . . made by one company, Janette Electric Manufacturing Company.

This simple statement accounts for the many advantages enjoyed by Janette users. And of major importance is the fact that the name JANETTE stands for undivided service responsibility.

The Janette tradition of "The Right Speed—The Right Power" acknowledged throughout industry, has evolved out of the basic engineering principle of balanced performance—possible only with "all in one—built by one" gear motors and speed reducers.

GROWING WITH INDUSTRY SINCE 1910

Janette ELECTRIC MFG. CO.

MORTON GROVE, ILLINOIS

MOTORS

Janette gives you these "ALL IN ONE" advantages:

Undivided responsibility for design and manufacture of all parts.

One continuous motor and worm shaft used to obtain perfect alignment and to prevent oil seal leakage.

No back lash movement between motor and worm to cause wear and reduce gear life.

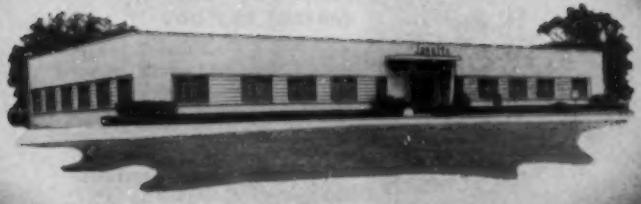
Motor ventilation is designed for blowing air over the gear box for additional cooling.

Motor, gears, shafts and bearings are designed as a balanced unit for balanced performance.

Correct balance of torque between motor and gears results in the right speed and output torque.

Extra capacity bearings used to take the end thrust of the worm and to give longer bearing life.

If yours is a problem in speed reduction, it will be to your advantage to investigate Janette products. Write for catalog showing 119 basic models, providing 239 mounting positions and more than 5,000 output speeds.



JANETTE GENERAL OFFICE
AND ENGINEERING BUILDING

When do you specify

design fasteners?

When they lower production costs. Southco Fasteners are designed for specific, not general, requirements to reduce installation time, to do a better job.

Southco engineers are available to help you select the right fastener for your particular needs. Write for the Southco Fastener Handbook. Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

© 1954

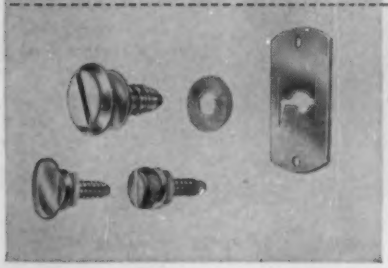
SOUTHCO FASTENERS

OFFICES IN PRINCIPAL CITIES

Pat. No. 2,640,612 other pats. pending. Rivet and Mfg.

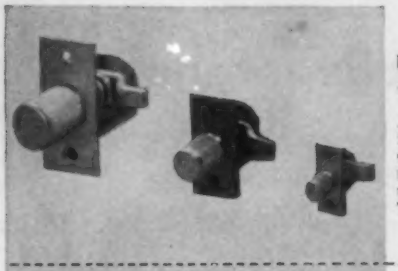
DRIVE RIVETS . . . installed with only a hammer

Make riveting as easy as nailing; a one man job out of a two man operation. For blind or access applications. Fasten metal-to-metal or metal-to-wood. Installation is quick, easy. Just hit the rivet pin with a hammer.



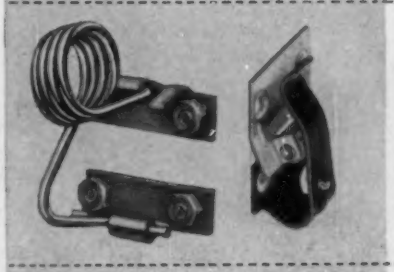
WIDE-TOLERANCE QUICK RELEASE FASTENERS

Ample length tolerance permits one size to cover wide variations in metal thickness and spacing. Simplify stock requirements by eliminating assortment of fastener sizes to accommodate variations in thickness. Floating screw assembly solves alignment problems. Easily installed.



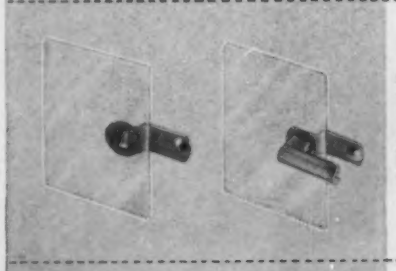
DOOR FASTENERS . . . with adjustable grip

Accommodate variations up to ¾ inch in engaging distance. Grip pressure adjusted by simply turning the knob. Pre-assembled unit is easily and quickly installed. Two head styles—flush or projecting.



DOOR SPRINGS . . . hold doors open and shut

Good for the life of the assembly. Hold doors both open and closed. Spring tension prevents rattle. Minimum space required. Available in coil or leaf springs.



DOOR LATCHES . . . installed in seconds

Low-cost, rugged, installed with unbelievable speed. Provide positive locking wherever used. Two types—handle or flush-head.

PERMANENT STEEL THREADS IN WOOD

Anchor nuts provide threads for metal screws, bolts, studs. Permit quick attachment or removal of parts as many times as required. Expansion takes place inside wood, wood laminates or composition materials; nothing projects to mar finished surfaces. Can't twist or pull out. Installation is easy.

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

From the collection of Lewis Winant, New Jersey Arms Collectors Club. Maker: Le Conte, Paris, France, 1758-1763. An 11-by-14 inch print of this illustration with part and lettering omitted is available free on request on company letterhead.

In producing this cam of sintered iron powder, Bound Brook competed directly with other forms of metal fabrication — and emerged victorious. Bound Brook's knowledge and experience with powder metallurgy combined the plus values of uniform density, consistent dimensional accuracy, good surface finish and high speed production to create a superior part at moderate cost. Whenever you are challenged with a metal-fabrication problem which is not easily solved by conventional metal-working methods why not call in your Bound Brook Man? There's no obligation for inquiring—and, in conjunction with your engineers, he could produce a winner!

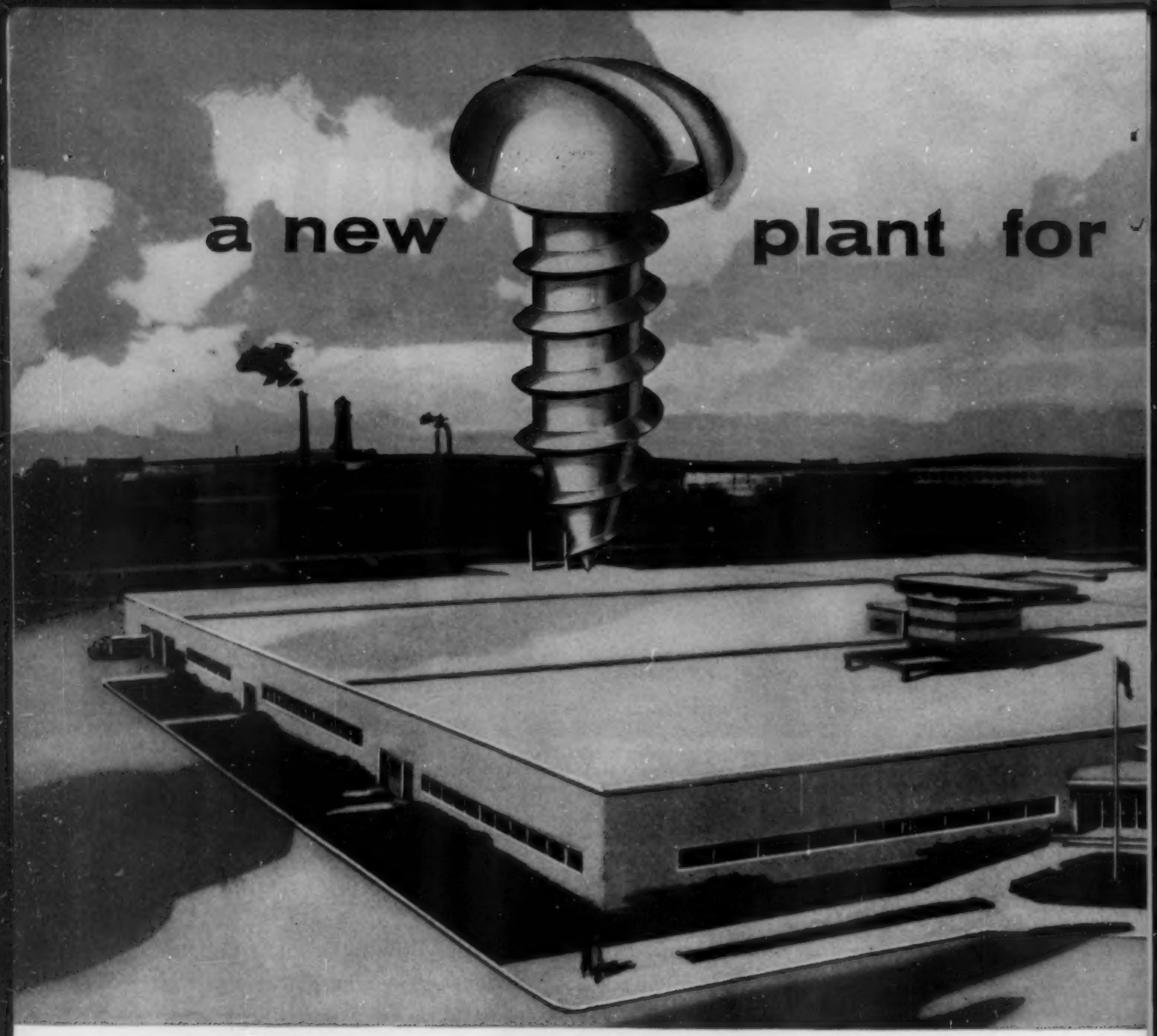
9

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

POWDER METALLURGY BEARINGS & PARTS



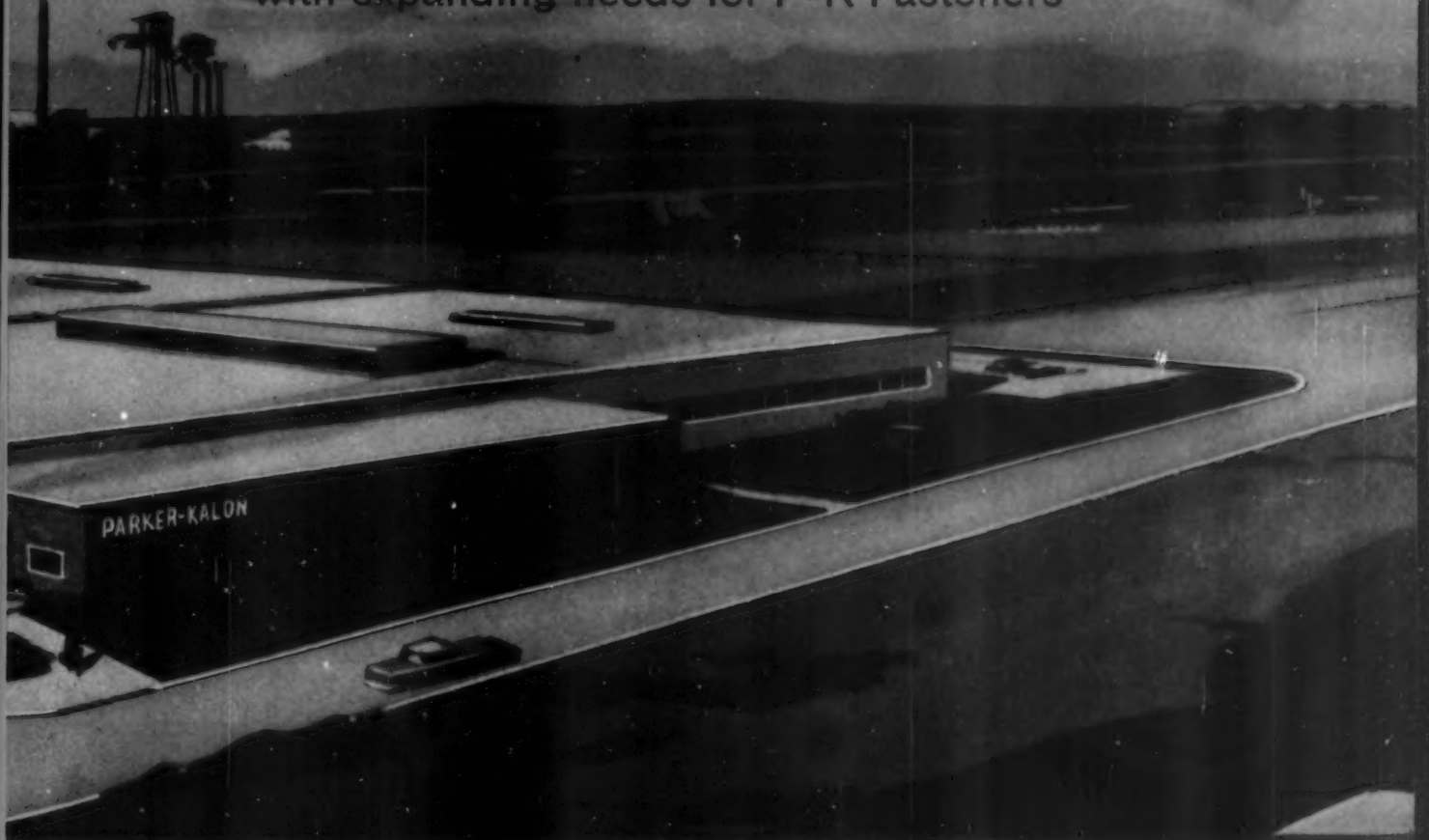
In a few weeks, Parker-Kalon will move to its new plant in Clifton, New Jersey (about 10 miles from New York City). This modern building, containing 267,000 square feet on one floor, is one of the largest plants devoted exclusively to the manufacture of fasteners.

It is planned for the highest efficiency and economy in all operations, with production keyed to the steadily increasing demand for P-K Fasteners throughout industry. Advanced facilities for engineering and research will accelerate P-K progress in development of new and improved fasteners.

Now, more than ever, you can be sure . . . "If it's P-K . . . it's O.K.!"

PARKER-KALON

to keep P-K production and progress in pace
with expanding needs for P-K Fasteners



PARKER-KALON®

PARKER-KALON DIVISION • General American Transportation Corporation, Clifton, New Jersey

SELF-TAPPING SCREWS • STAPS • SOCKET SCREWS • SCREWNAILS • MASONRY NAILS • WING NUTS • THUMB SCREWS

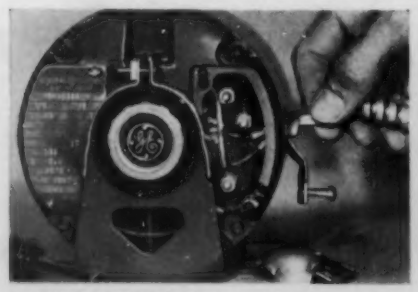
Sold through leading Industrial Distributors.

All these smaller, lighter G-E motors

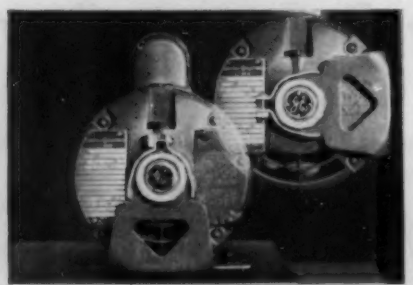
SMALLER, LIGHTER DESIGN—as much as 40% smaller and 50% lighter—speeds assembly and cuts product shipping weight.

MYLAR* INSULATION (right): 35 times the moisture resistance, 8 times the dielectric strength of paper insulation (left).

ALL-ANGLE OPERATION—lubrication is sure and protective when mounted in any position; no need for costly specials.



EASY CONNECTION—terminals are close to cover plate; speed-nut welded inside shell for fast connection from outside.



MOUNTING VERSATILITY—with resilient *or solid* cradle bases, you can rotate *any* G-E motor to meet your design needs.

DOUBLE LUBRICATION LIFE—50% more oil capacity and more efficient oil retention system cut G-E motor maintenance.

*DuPont trade-mark.

are available now in ratings you need

Act today to cut YOUR costs on material, assembly, shipping!

You have the opportunity to save *now* with smaller, lighter fractional-hp motors. General Electric, which pioneered these advanced motors three years ago, now offers prompt delivery on more than 850 *basic* models—including the right motors for *your* products.

IMPROVED PRODUCTS—plus savings in material, assembly, and shipping—await your conversion to these "years-ahead" G-E motors. For example: a compressor builder cut over-all manufacturing costs 25%. A pump manufacturer doubled sales of his streamlined product. A third manufacturer has reduced his shipping costs by 35%.

PROVED PERFORMANCE of smaller, lighter G-E motors on nearly 4,000,000 products demonstrates the superiority of the features listed at left.

TO HELP YOU realize *all* these benefits, G.E. offers application aid from engineers who have helped apply these advanced motors to all types of products.

WHY WAIT? Prompt delivery of the G-E motors you need can help you carry out a quality-boosting, cost-cutting program on your products without delay. For full information, including case histories of actual cost savings with G-E fhp motors, contact your G-E Apparatus Sales Office today. Or write Section 702-23, General Electric Co., Schenectady, N. Y.

Progress Is Our Most Important Product

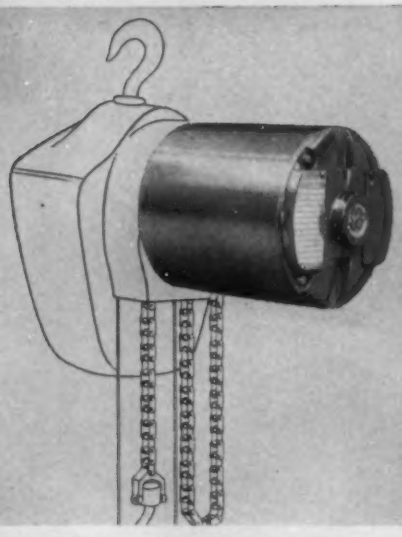
GENERAL ELECTRIC

ON NEXT PAGE
3 examples of
G-E motor benefits
in action

HOW SMALLER, LIGHTER G-E FHP MOTORS HELP

IMPROVE YOUR PRODUCT PERFORMANCE

ON MATERIAL-HANDLING EQUIPMENT



G-E BRAKE-MOTORS, ¼ to ¾ hp, provide positive braking or holding for overhead doors, small elevators, etc. Brake adjustment, usually unnecessary, is simple. Combined manual release and wear indicator is easy to operate, permits visual inspection. Bulletin GEC-1273.

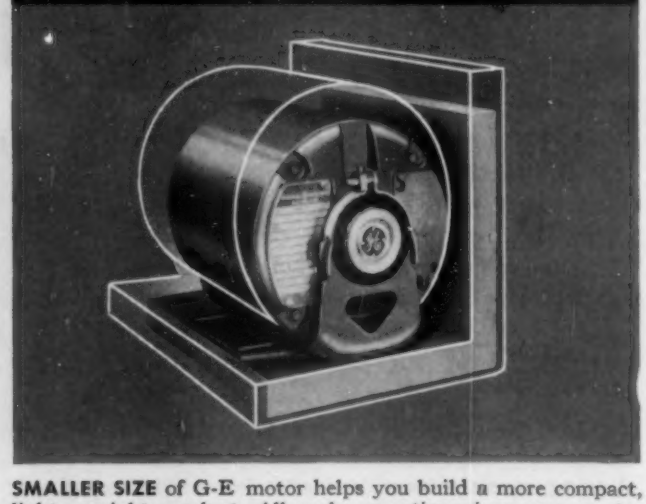
"PACKAGED" G-E GEAR-MOTORS for conveyors, hoists, etc., are the most compact low-speed drives available. Installation is fast and simple. Only maintenance normally required is infrequent lubrication. Concentric- or right-angle shaft, ¼ to ¾ hp. Bulletin GEA-6133.

THREE-QUARTER MOTORS save space, provide compact, lightweight power for "built-in" applications on cranes, hoists, etc. High-torque performance assures ability to easily start and run heavy loads. Single-phase motors available for instantly reversing operation. ¼ to ¾ hp.

ON ELECTRIC DOOR OPERATORS

50% LIGHTER WEIGHT of "years-ahead" G-E motors makes installation much easier. Valuable space is saved because of 40% smaller size. Doubled lubrication life minimizes maintenance in hard-to-reach places. Available for all types of doors and control systems. ⅙ to ¾ hp. See Bulletin GEA-5567.

ON FOOD-PROCESSING EQUIPMENT



SMALLER SIZE of G-E motor helps you build a more compact, lighter-weight product. All-angle operation gives you greater design flexibility without special motors. Absence of high-pitch noise in the magnetic circuit means extra-quiet operation. Complete line ⅙ to ¾ hp. Bulletin GEA-5567.

FOR FULL INFORMATION on these and other G-E fhp motors, contact your nearby G-E Apparatus Sales Office. And write for Bulletins listed to General Electric Co., Sect. 702-23, Schenectady, N. Y.

GENERAL ELECTRIC

lubricating "brains" built into any machine!

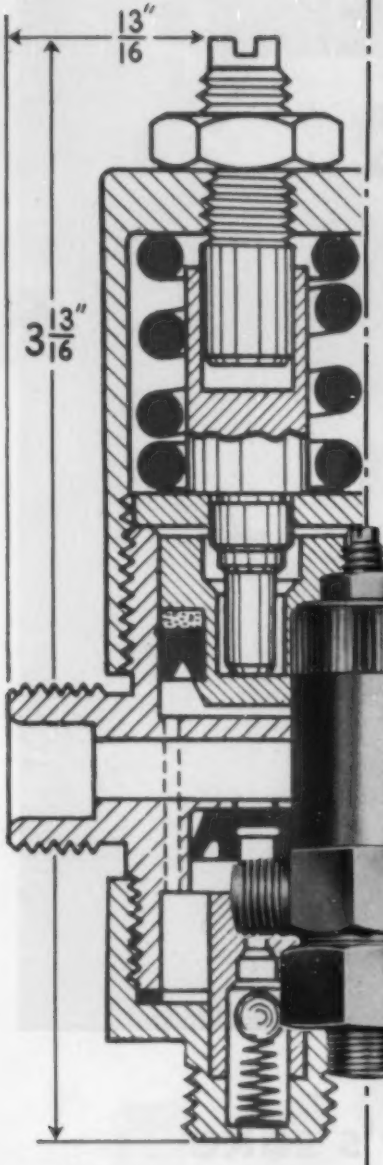
ALEMITE Accumatic®

lets you design automatic, fool-proof lubrication right into any machine — simply, economically . . . offers the operating savings industry will buy!

When a machine is designed with multiple lubrication fittings that require manual attention, the user of that machine is sure to encounter a number of problems. People being what they are, some bearings will be neglected, others over-lubricated. Further, hand lubrication is costly and valuable production time is lost when machines must be shut-down for lubrication.

You avoid all of these troubles with the Alemite Accumatic. This amazing valve fits directly on bearings—meters an exact shot of oil or grease *automatically—at pre-determined intervals—while the machine is in operation!* Time, production and maintenance costs are cut to the bone! With all these advantages, it is small wonder that 95% of all major plants buying machine tools specify centralized lubrication.

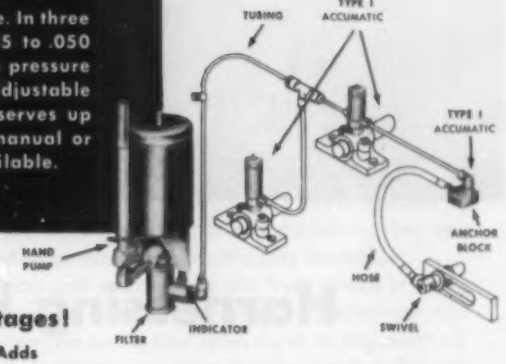
The Alemite Accumatic system is simple to design and build into any machine. Automatic Accumatic Systems assure you positive, low-cost lubrication. Find out about these automatic systems now. See the savings, the efficiency they add and you too will specify Accumatic!



Adjustable Output/Cap.

Type 1 Accumatic Valves

For fluid oil or light grease. In three sizes, delivering from .005 to .050 cu. in. of lubricant. Spring pressure provides gradual feed. Adjustable or fixed output. System serves up to 400 bearings. Either manual or automatic operation available.



Offers All These Advantages!

- Eliminates shut-down time for lubrication. Adds productive time to machine output.
- Seals completely against dirt, grit, water all the way from "Barrel-to-bearing."
- Prevents bearing troubles due to neglect or use of wrong lubricant.
- Services all bearings — including those inaccessible or dangerous — in one operation.
- Avoids work spoilage and bearing repairs due to over-lubrication.

Factory-tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—equal to 122 YEARS of *twice-a-day service!*

ALEMITE
REG. U. S. PAT. OFF

A PRODUCT OF SW STEWART WARNER

FREE!

ALEMITE, Dept. T-115
1850 Diversey Parkway, Chicago 14, Illinois

Please send me my free copy of the Alemite Accumatic Catalogue and Engineering Data Book.

Name .....

Company .....

City ..... State .....

Harnessing heat for safety's sake

3M ADHESIVES

A temperature of 215° F. is just too hot to handle, no matter where you find it. Yet today's wall-type room heater must operate at just such a temperature *inside*, while staying cool enough on the *outside* so that even a child can touch it in perfect safety. What's behind this bit of modern insulation magic? A 3M product called EC-226—the versatile adhesive you see in action above.

Applied quickly and easily by spray, EC-226 has "quick strength" . . . takes a gentle grip on the insulation immediately upon contact, simplifying the manufacturer's assembly operation. Then the adhesive dries to form a lasting bond that *keeps* the insulation at its cooling job—without a slip—despite the boiling-hot temperatures generated inside the heater.

See what adhesives can do for you . . .

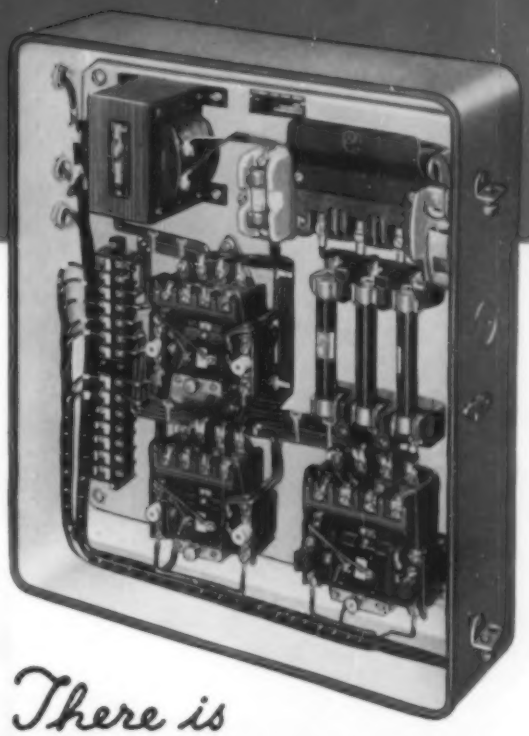
Call upon 3M research for the solution to your specific design or production problem. Call an expert, your nearest 3M Field Engineer—or write for further information to 3M, Dpt. 411, 417 Piquette, Detroit 2, Mich.

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N.Y. 16, N.Y. • CANADA: P.O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS

Oakes mixing machine for continuous mixing of raw materials in the rubber and chemical industries.

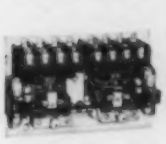


Close-up of Allen-Bradley automatic motor control panel.

A-B Quality

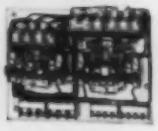
The Sign of QUALITY MOTOR CONTROL

Service-tested Components for Automation Control Panels



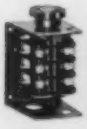
Reversing Switch

Solenoid Starter



Multispeed Starter

Solenoid Relay



Pilot Switch

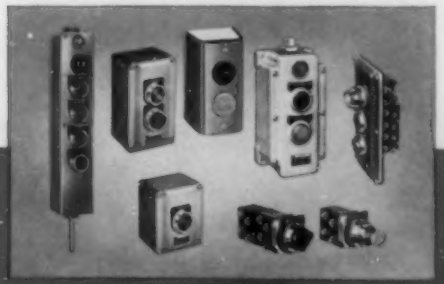
Drum Switch

Pneumatic Timer

Pressure Switch

Zero Speed Switch

Limit Switches



Push Buttons

There is SALES VALUE for YOU in the A-B TRADEMARK

Time has established the A-B trademark as the sign of Quality in motor controls. It is so recognized by the buyers of your motorized machines. So, why not standardize on Allen-Bradley controls.

Years and years of trouble free service in every conceivable industry has proved conclusively that A-B controls are a real sales asset to any machine. You just cannot beat Allen-Bradley controls for simplicity in design . . . your guarantee for reliable and consistent performance.

Whether you need a single starter or an all-inclusive special control panel, call in your nearest Allen-Bradley sales engineer. Let him recommend the components that will assure the most continuous output from your machines.

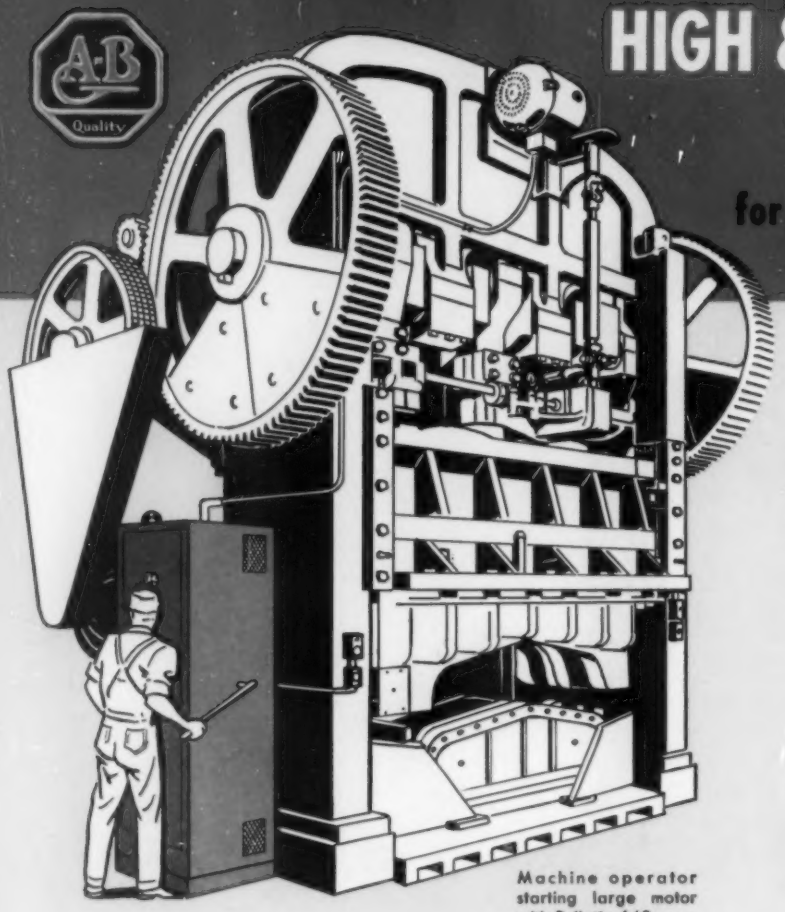
Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wisconsin

In Canada—Allen-Bradley Canada Ltd.
Galt, Ont.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

9-55-MB

HIGH & LOW VOLTAGE STARTERS for BIG MOTORS



Machine operator starting large motor with Bulletin 640 manual velvet smooth resistance starter. Starting jolts are eliminated.

BIG STARTERS for big motors . . . for 220-440-550 volts . . . for 2000 to 2500 volts . . . and for 2501 to 4600 volts . . . are catalog listed units in the Allen-Bradley line. Illustrated below is a limited variety of starters for squirrel cage, wound-rotor, and synchronous motors. Starters for manual or automatic operation are available. Starters for 600 volts or less are available in ratings up to 600 hp. High voltage starters are rated up to 1500 hp.

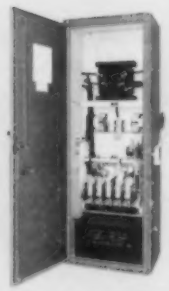
Write for a copy of the Allen-Bradley Handy Catalog in which all varieties of "big starters" are listed. It is also a handy buyer's guide on the latest developments in controls and accessories.

Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wisconsin

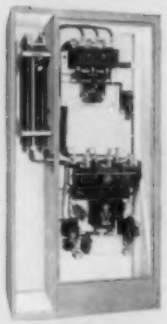
In Canada
Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

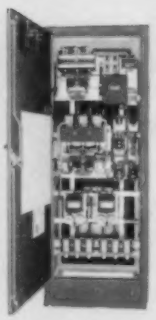
A FEW OF THE BIG STARTERS IN THE ALLEN-BRADLEY LINE



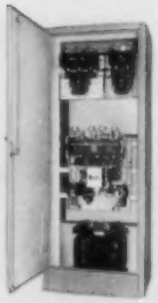
Bulletin 646 manual autotransformer type starter



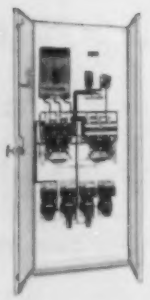
Bulletin 740 automatic reduced voltage motor starter



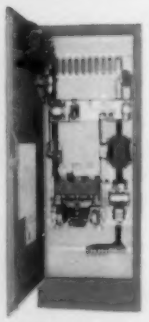
Bulletin 742 automatic starter—velvet smooth acceleration



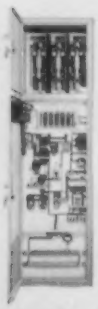
Bulletin 746 automatic autotransformer type starter



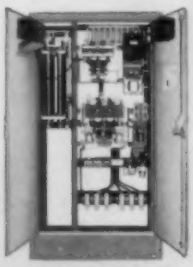
Bulletin 761 automatic wound-rotor motor starter



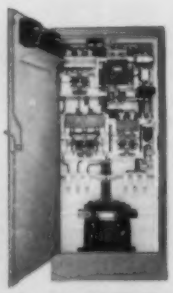
Bulletin 906 across-the-line synchronous motor starter



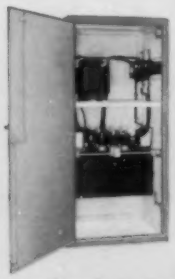
Bulletin 906 high voltage synchronous motor starter



Bulletin 914 reduced voltage synchronous motor starter



Bulletin 922 low voltage synchronous motor starter

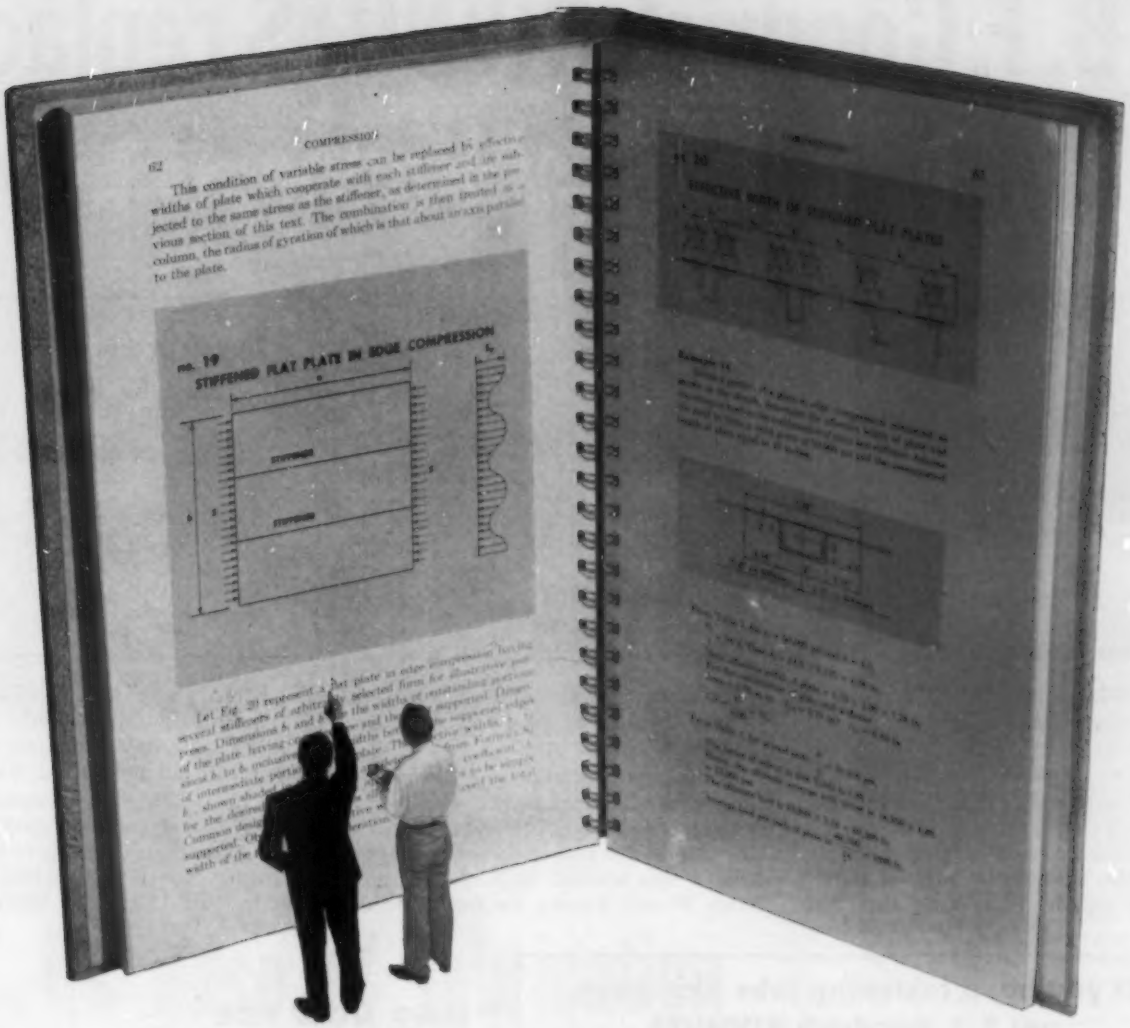


Bulletin 922 high voltage synchronous motor starter

Bulletin 1109 high voltage across-the-line starter

Bulletin 1146 high voltage squirrel-cage motor starter

9-55-MR


82
COMPRESSION
This condition of variable stress can be replaced by effective
widths of plate which cooperate with each stiffener and are sub-
jected to the same stress as the stiffener, as determined in the pre-
vious section of this text. The combination is then treated as a
column, the radius of gyration of which is that about an axis parallel
to the plate.
no. 19
STIFFENED FLAT PLATE IN EDGE COMPRESSION
STIFFENER
STIFFENER

You'll find it all here . . .

The information you need when designing for high strength steels

OUR new "Design Manual for High Strength Steels" is ready for distribution. Here are 174 pages of practical, authoritative information that you will find invaluable in designing your product for greater economy and efficiency by the sound use of high strength steels. No designer should be without it.

This excellent book covers in detail the problems of tension, compression, shear, beam stress, deformation and deflection. It fully describes the fundamental characteristics of low-alloy high strength steels, shows you how to design against corrosion, describes the application of formed sections. Complete with tables, formulas, and basic data covering this important field of design.

• • •

For your free copy, write on your company letterhead giving your title or department, to United States Steel Corporation, Room 5013, 525 William Penn Place, Pittsburgh 30, Pa.

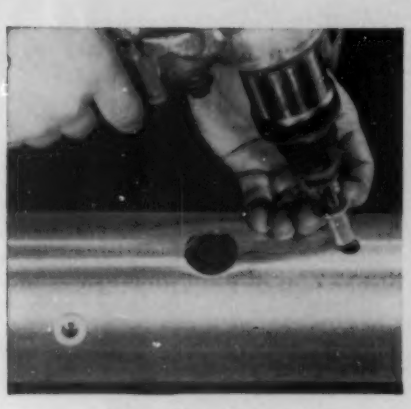
UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

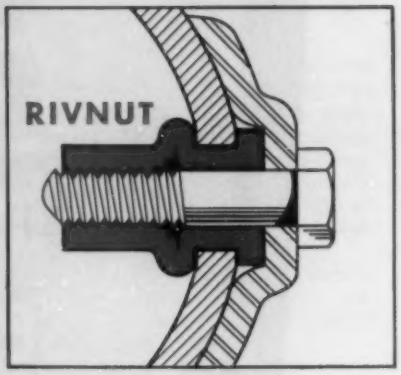
USS HIGH STRENGTH STEELS

USS MAN-TEN • USS COR-TEN • USS TRI-TEN

UNITED STATES STEEL

3 B. F. Goodrich RIVNUTS replace 4 nuts—cut assembly costs 50%





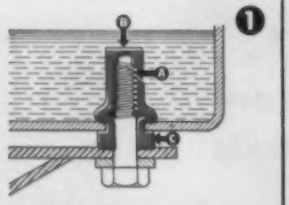
B. F. GOODRICH RIVNUTS provide a firm, accurate nut plate in one, quick operation. Nuts, welding, tapping and clinching are eliminated.

In the street light application illustrated, it used to take two men to fasten the arm bracket to the pole with nuts and bolts. Then Pfaff & Kendall, world's largest supplier of tubular aluminum poles, redesigned the unit to use Rivnuts. Now one man does the job in the same amount of time.

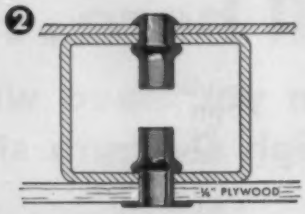
At the factory, (top left) a worker installs the Rivnuts in the aluminum pole in seconds. In the field, the assembler slips the slotted part of the arm bracket over a bolt screwed halfway into the lower Rivnut. Resting the arm on this bolt, he screws the top two in place; tightens all of them (middle photograph). Tests show that the pole or arm bracket will fail before the Rivnuts.

If you're looking for a fastener that can help you cut costs, get more information on Rivnuts or engineering help by writing: The B. F. Goodrich Company, Dept. PE-115, Akron, Ohio.

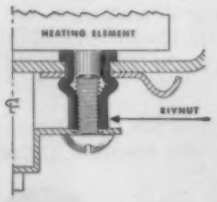
If you have fastening jobs like these, get B. F. Goodrich RIVNUTS



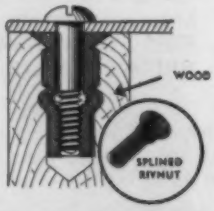
ELIMINATES BRAZING! Rivnuts with closed end (B) are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated (A). Spacer head (C) positions tank.



FASTENS PLYWOOD TO STEEL! Easier to install than wood or self-tapping screws, Rivnuts fasten plywood walls to tubular steel sections in trailers. No wood filler needed.



ELIMINATES REINFORCING PLATE! In assembly of vaporizers, Rivnuts do away with reinforcing plate, don't turn under torque, hold flange securely without bending. Result: less assembly time, fewer parts, better product.



GIVES 6 CLEAN THREADS IN WOOD! Special Rivnut for solid fastening in wood eliminates wood screws, provides 6 metal threads for attachment bolt. Bulge formed by upsetting holds Rivnut fast. Splined shaft keeps it from turning.

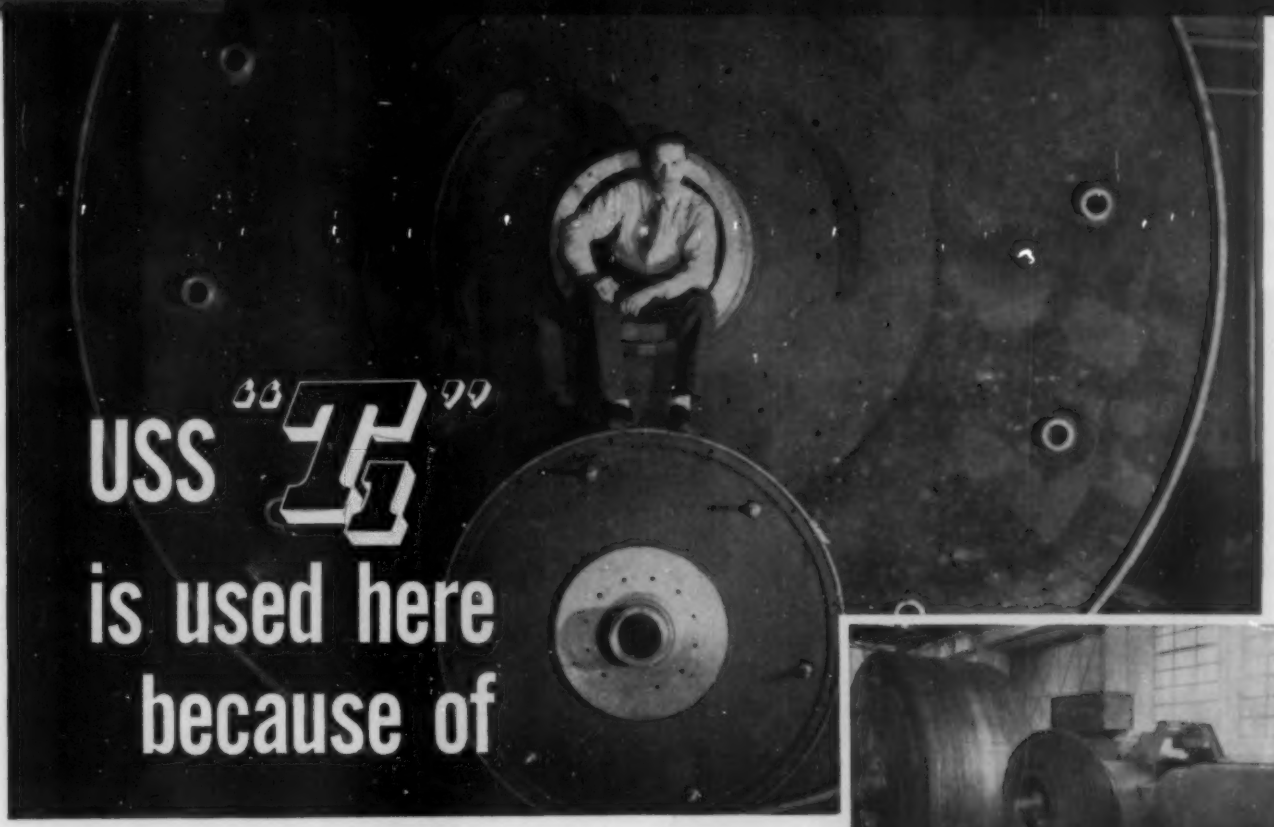
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Department PE-115, Akron, Ohio.

B.F.Goodrich

RIVNUT

The only one-piece blind rivet with threads



USS "T-1" is used here because of

'ROUND AND 'ROUND the flywheel goes, at a speed of 300 mph. Suddenly, an aircraft wheel assembly rams against it, with the impact of a loaded airplane. The tire squeals, the brake is applied, and in just 20 seconds the wheel stops. A real rugged test—both for the wheel assembly and for the steel in the flywheel. USS "T-1" Steel passed the test. In fact it is the best steel that could be used for this high speed application.

...its great strength

...its ease of fabrication

High speed tire, brake, and wheel testing machines like the one shown here, manufactured by Adamson United Company, Akron, Ohio, a subsidiary of United Engineering and Foundry Co., are used to prove out aircraft landing gear. The gigantic flywheels on these machines simulate the speed and inertia of an actual airplane during landing and take-off.

Until a short time ago, testing machines were built to rotate at peripheral speeds up to 250 mph. But when the aircraft industry spread its wings, faster testing machines were needed. The new machines had to rotate at speeds as high as 300 mph—and stay in one piece. They had to be extremely strong . . . lightweight . . . and easy to fabricate.

That's when USS "T-1" Steel entered the picture.

For flywheels rotating 300 mph, a steel of extremely high tensile strength was needed to withstand the tremendous stresses generated. A steel permitting the greatest strength for the thinnest section was needed. And, above all, the steel had to be capable of developing full 100% weld strength.

USS "T-1" Steel more than met all Adamson United's requirements.

Other steels could have provided the strength and met the weight requirements. None but "T-1" provided these and good weldability too.

UNIQUE PROPERTIES—"T-1" Steel's unique combination of physical properties has solved many similar problems. "T-1" can be welded satisfactorily *without* pre- or post-heating —it can be welded either in the shop or field. Always, it provides great tensile strength (105,000 psi minimum with yield strength of 90,000 psi minimum), phenomenal toughness and excellent abrasion resistance. Write for full particulars. United States Steel, Room 5016, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

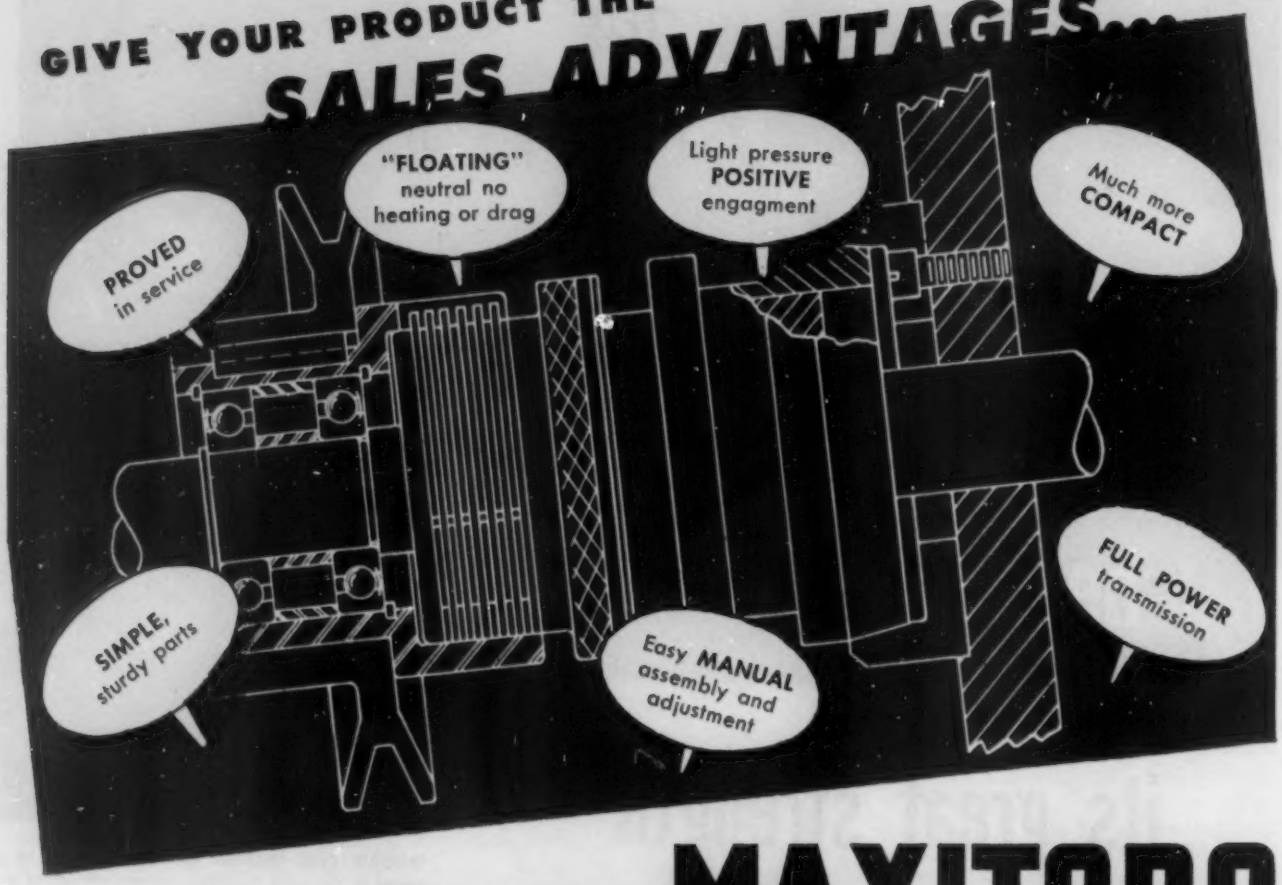
UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

UNITED STATES STEEL

GIVE YOUR PRODUCT THE

SALES ADVANTAGES...



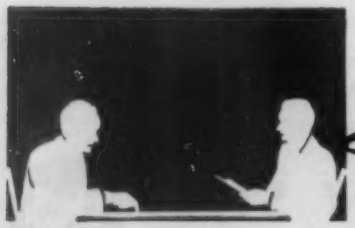
...OF A PROVEN MAXITORQ

floating disc

CLUTCH

The above line drawing illustrates a single MAXITORQ Clutch arranged for single V-belt drive with a special sliding beveled shifter sleeve acting as a light brake.

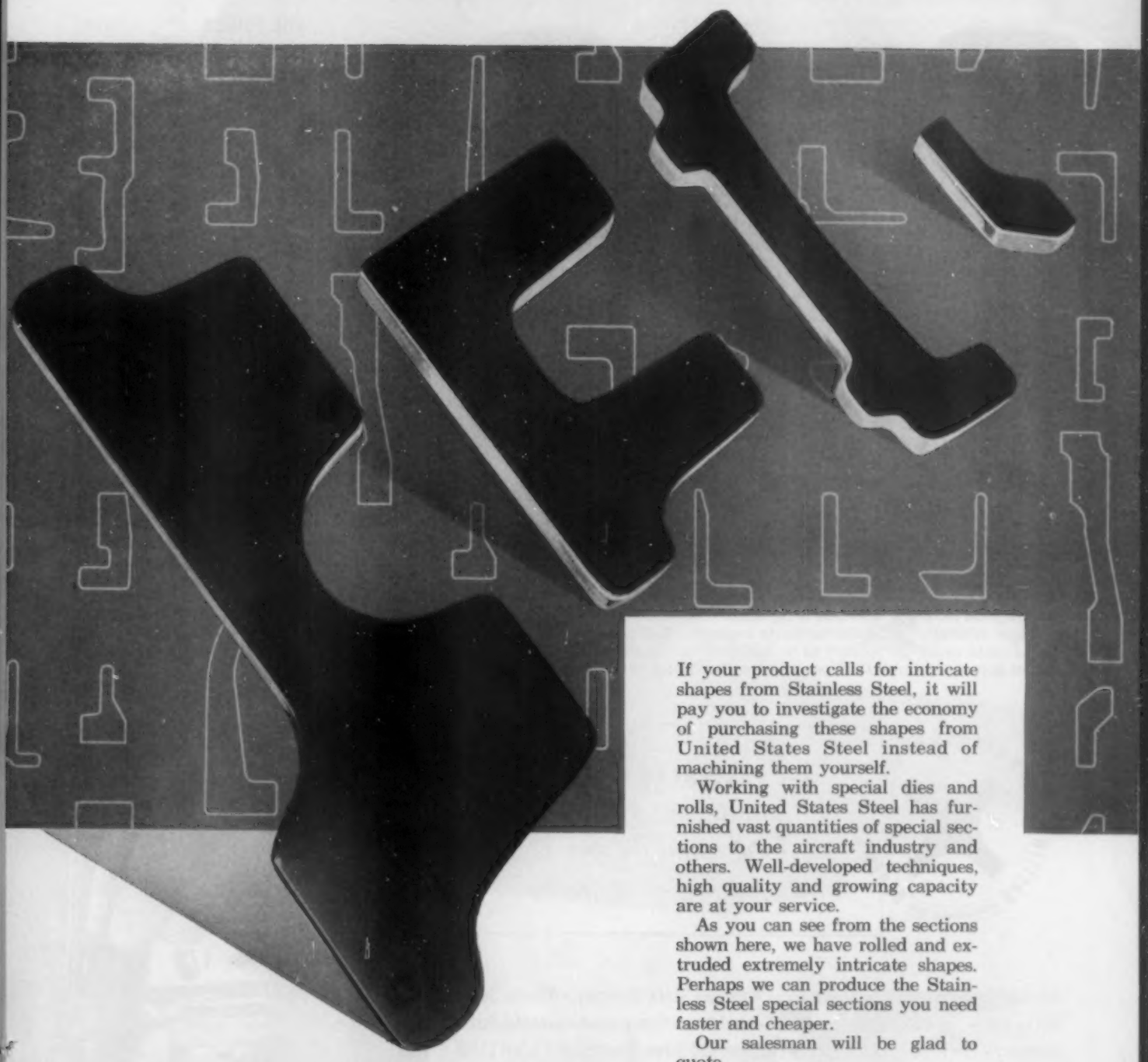
Yes, there are many types of MAXITORQ . . . single, double, overload release . . . to meet every installation need. Get our comprehensive technical data . . . let our engineering department help you work out special drive problems. Write or phone: Dept. PE-11, The Carlyle Johnson Machine Company, Manchester, Conn.



Let's talk MAXITORQ

SCJ55

You can save machining costs with special sections–rolled or extruded of **USS STAINLESS STEEL**



If your product calls for intricate shapes from Stainless Steel, it will pay you to investigate the economy of purchasing these shapes from United States Steel instead of machining them yourself.

Working with special dies and rolls, United States Steel has furnished vast quantities of special sections to the aircraft industry and others. Well-developed techniques, high quality and growing capacity are at your service.

As you can see from the sections shown here, we have rolled and extruded extremely intricate shapes. Perhaps we can produce the Stainless Steel special sections you need faster and cheaper.

Our salesman will be glad to quote.

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

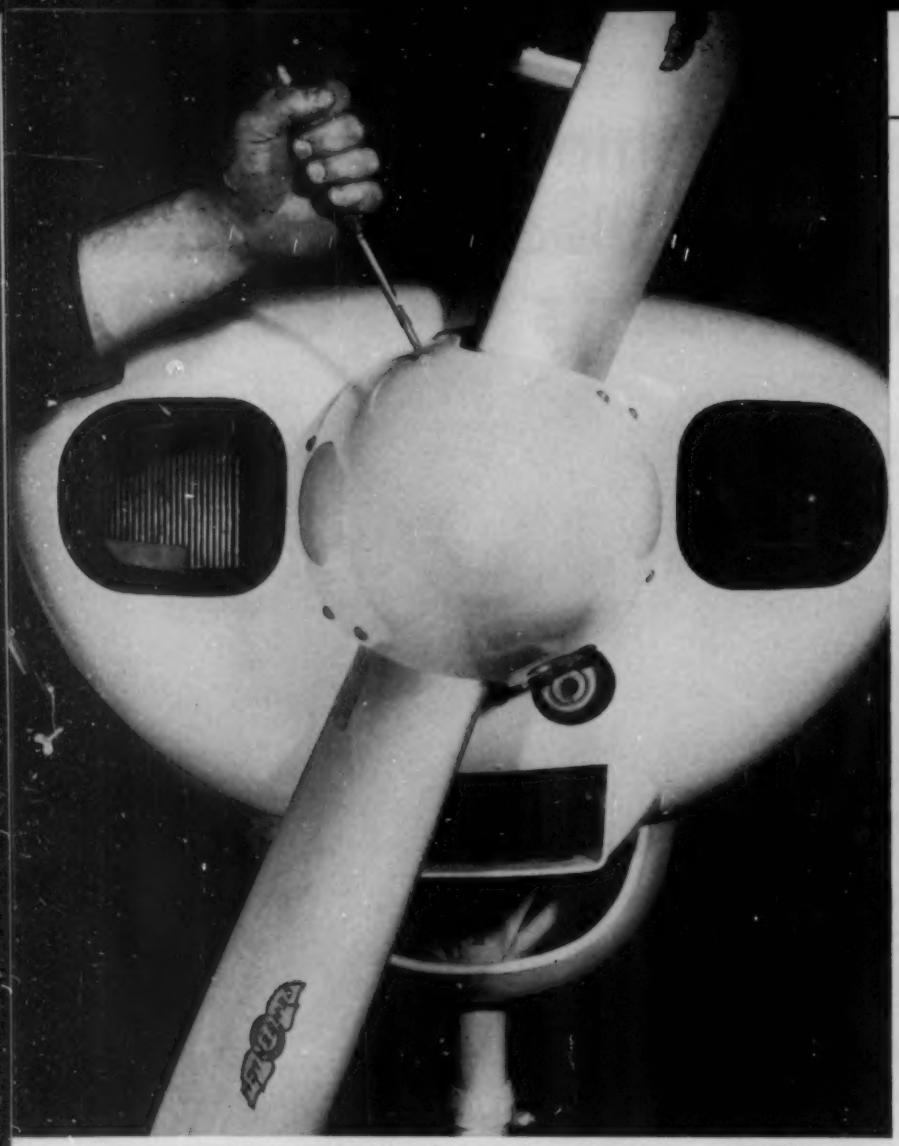
USS

UNITED STATES STEEL CORPORATION, PITTSBURGH
AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION,
WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

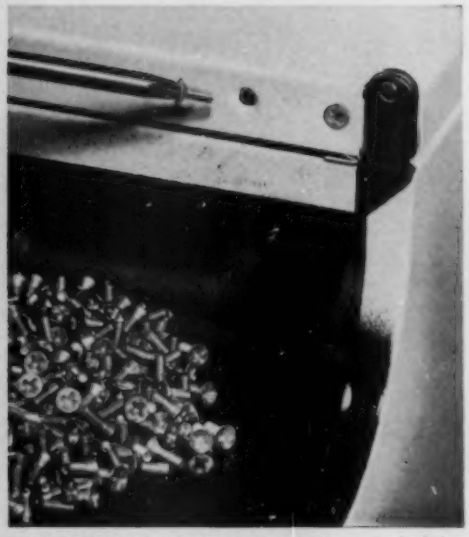
UNITED STATES STEEL

SWIFT, SURE ASSEMBLY

... with Phillips
Cross-Recessed-Head Screws



"PROTECTION AGAINST SLIPPAGE is the main reason why we use Phillips screws at Piper Aircraft," says the methods engineer. A slip of the driver in this photo could cause the spinner to be taken off and repainted. But there is no fear of slippage because Phillips drivers securely seat themselves.

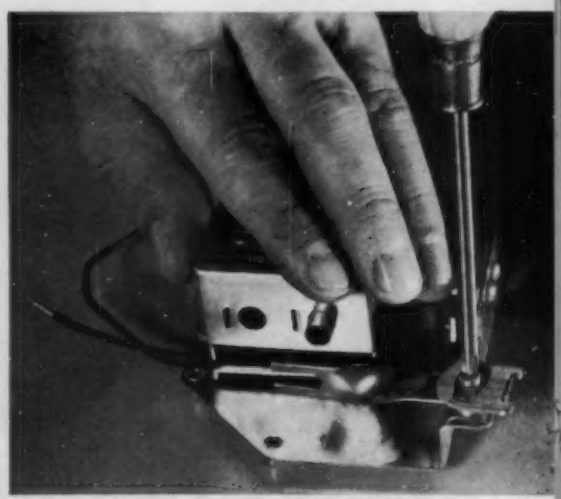


"SWIFTER ASSEMBLY, more contact and driving power with Phillips screws have enabled us to use production methods which were impossible with other type screws," says the general manager of Tracy Kitchens. Shown here is a closeup of 6-32 x ⅜" Phillips flat head screws securing the door of an under-sink cabinet.

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY...
AND OF THE FUTURE
X marks the spot
the mark of extra quality

Allmetal Screw Products Company, Inc. • American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company • Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Company Rockford Screw Products Company • Scovill Manufacturing Company • Shakeproof Division Illinois Tool Works • The Southington Hardware Manufacturing Company Sterling Bolt Company • Universal Screw Company • Wales-Beech Corporation



"A BETTER LOOKING FIXTURE is obtained by the use of Phillips cross-recessed-head screws on our 8-Tone chime," says the chime engineer of Nutone Incorporated of Cincinnati, Ohio. "If screws must be used on the exterior of any unit, I definitely feel Phillips recessed head screws are the very best choice."

From a dream-world marriage of mathematics and electronics...tomorrow's oil seals today

Looks simple, doesn't it—the oil seal pictured here. Actually, it's a precision assembly of high tolerance parts, each the product of painstaking engineering.

One such part is the unseen but vital tension spring behind the sealing lip. Thousands of these springs—all different—are needed in the broad line of National Oil Seals. Each spring must have exactly the size, coil diameter, tension, spring rate, and heat treat required for the oil seal it fits.

Done the conventional way, calculations of characteristics for thousands of springs would take months. So, National Oil Seal Engineers developed new mathematical methods which, in combination with Univac, permit specifications to be determined at speeds up to 150 per minute.

This fortunate marriage of mathematics and electronics is another example of efficient, "future" National Oil Seal engineering—and another reason why National consistently brings you tomorrow's oil seals today.

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

New Sealing Lip Design. Recent development of NMB Engineering is new lip design. New features include long, thin lip section and small coil diameter tension-spring. Contact on shaft is light, yet effective sealing is maintained throughout long service life.

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, California and Van Wert, Ohio

3048

3 New MARVINOL RESINS

broaden your choice of PVC processing qualities

	MARVINOL VR-10	MARVINOL VR-20	MARVINOL VR-21
Description	General Purpose.	Film Calendering.	Cold, dry premix for calendering film and sheeting.
Special Features	Highest molecular weight. Low deformation at highest temperatures. Very fast mill or Banbury mixing. Good for foaming and dispersion applications. Good for blown extruded film. High speed extrusion.	Medium molecular weight. Recommended primarily for calendered film. Behaves well in hot or cold premixes. High bulk density for large Banbury charges.	High molecular weight, cold, dry premixing resin. Leaves mixers clean, minimizing color changeover problem. Recommended primarily for calendering film, sheeting and coated fabrics.
Resin Properties			
Specific Viscosity	0.52	0.38	0.44
Average Apparent Density, lbs/cu. ft.	26	32	22
Average Particle Size, microns	6	32	11
Acetone Solubility	20	37	31
Specific Gravity	1.40	1.40	1.40
Compound Properties* (100 parts resin, 50 parts DOP)			
Shore "A" Hardness	82	78	80
Tensile Strength, psi	2900	2600	2800
Ultimate Elongation, %	340	360	360
100% Modulus, psi	1475	1300	1425
Tear Strength, lbs/in.	480	430	460

MARVINOL DATA REQUEST FORM

NAUGATUCK CHEMICAL,
Div. United States Rubber Company, Naugatuck, Conn.

Please send Technical Data on Marvinol resins checked at right.

Name.....Title.....
Company.....
Address.....
City.....Zone.....State.....

☐ VR-10
☐ VR-20
☐ VR-21
☐ VR-22
☐ VR-24
☐ VR-30
☐ VR-50

☐ *Do* (☐ *Do not*) have your Technical Representative call on me. PE

*Compound properties shown above are intended primarily for comparison with other Naugatuck resins, all of which are tested on the same equipment. Comparison with similar figures on resins of other manufacturers can be very misleading, since values obtained with different testing equipment may vary widely, even though the same methods are used.

HERE'S the current family of MARVINOL vinyls, industry's most complete line of straight polyvinyl chloride resins! Whatever your processing equipment . . . whatever your end product, there's a MARVINOL resin ideally suited to your needs!

For instance, do you want an easy-processing calendering resin designed especially to permit lower temperature operation? Then choose the new MARVINOL VR-24. If you're looking for a dispersion resin that readily stirs into plasticizers, there's the new MARVINOL VR-50. If it's a good electrical grade resin you need, MARVINOL VR-22 is approved by Underwriters' Laboratories, Inc.

Faster calendering? Larger Banbury charges? Easier dry blending? Choose the right MARVINOL® resin and they are yours!

May we send you Technical Data Sheets on any of these outstanding PVC resins? There's a form below for your convenience.

MARVINOL VR-22	New MARVINOL VR-24	New MARVINOL VR-30	New MARVINOL VR-50
Electrical Grade. Hot, dry blend for extrusion.	Easy processing and calendering.	Cold, dry premix for coated fabrics, film, sheeting and calendering.	Paste Dispersions.
High molecular weight with high bulk density for large Banbury charges. Excellent hot, dry blending properties for extruder feed; reduces mixing cycles. Approved by Underwriters' Laboratories, Inc. for electrical applications.	Low molecular weight with high bulk density, designed for low temperature calendering. Can be hot dry-blended. Can be used in semi-rigid compounds.	Medium molecular weight, low bulk density. Minimizes mixer clean-out problems. Mills and Banburys rapidly. Particularly good for most phases of calendering: film, inflatables, sheeting and coated fabrics. May be heat sealed. Excellent for injection molding.	Stirs into plasticizers readily to form pastes of good shelf life and excellent viscosity characteristics, for cloth-coating, dipping, slush molding, film casting, spraying and rotational molding. Makes excellent organosols.
0.44	0.30	0.38	0.50-0.52
27	33	21	15-19
22	25	15	—
25	51	46	—
1.40	1.40	1.40	1.40
			Physical Properties 6 mil Film, 380° F. (100 parts VR-50, 66.6 parts DOP)
80	77	78	
2800	2200	2800	
340	270	350	Tensile, psi 2700
1500	1300	1450	Elongation, % 280
450	370	410	100% Modulus, psi 1300

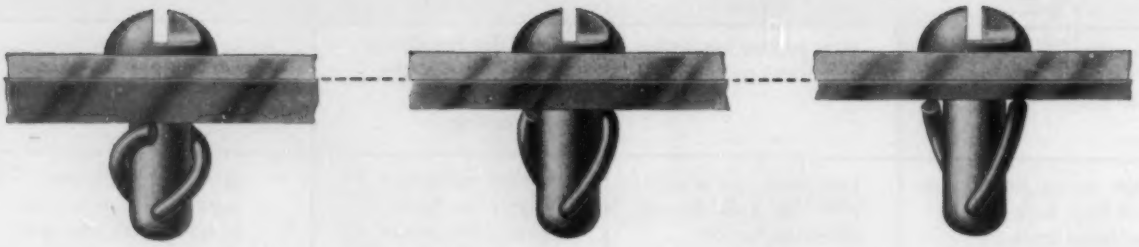
Naugatuck Chemical

Division of United States Rubber Company

Naugatuck, Connecticut

BRANCHES: Akron • Boston • Gastonia, N.C. • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N. Y.

This fastener works through thick and thin!



Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

SIMMONS FASTENER CORPORATION

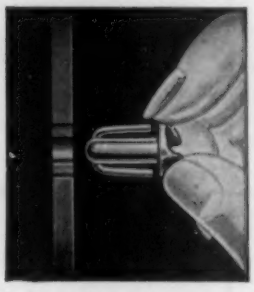
1751 North Broadway, Albany 1, New York

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCK WORKS



1. *Insert fastener.*

2. *Half-turn locks it in place.*

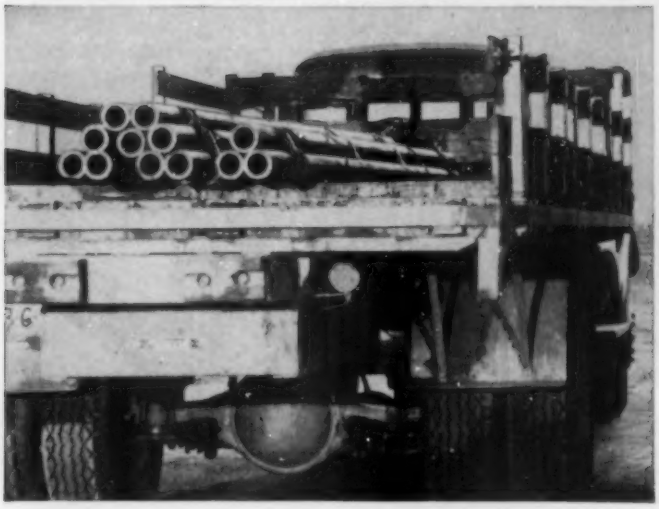
With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

Your order of...

TIMKEN® 52100 steel tubing goes from here



...to here within 24 hours!

GOT a rush hollow parts job? Phone, wire or write the Timken Company. We'll ship you less-than-mill quantities of 52100 steel tubing from mill stock within 24 hours after receiving your order. It's the ideal steel for many of your hollow parts jobs.

Besides saving you time, Timken® 52100 steel tubing can save you money. It can be substituted for more expensive steels. It's through-hardened in moderate sections and can be heat treated to file hardness and tempered back to any desired point.

Available in sizes from 1″ to 10½″, Timken 52100 steel is especially suited for hollow parts jobs like aircraft parts, ball bearing races, pump parts and plungers, collets, bushings, spindles, grinding machine parts, and precision instruments.

As America's pioneer producer of 52100 steel, the Timken Company has unequalled experience, assuring you of uniform quality from tube to tube and heat to heat. And we're the only company that makes 52100 steel in tubes, bars and wire.

For fast delivery of your less-than-mill quantity orders, pick up your phone right now. Call The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, O. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Twice the life of materials previously used is reported for this group of Ni-Vee bronze half bearing castings used in the first six or eight rolls each side of rollout table on large reversing mills. Ni-Vee type bronze castings are used for various heavy duty steel mill maintenance jobs. Castings shown on this page were produced by A. W. Cadman Manufacturing Company, Pittsburgh, Pa. under their trade name "NICUITE."

NI-VEE bronzes double life of parts in rollout tables and other mill machines

STRENGTH UP TO 90,000 psi and high resistance to wear, impact and galling characterize Ni-Vee bronzes.

Other advantages include easy castability, low shrinkage, pressure tightness, fine grain, economy and versatility.

Containing 5 per cent nickel and 5 per cent tin, Ni-Vee bronzes increase life of gears, cams and similar "constructional" castings. Likewise, the life of "pressure" group castings such as pumps, valves and fittings.

And for bearings, bushings and anti-friction metal, leaded Ni-Vee bronzes process into hard, wear-resistant products that are unmatched by the usual lead-free compositions.

Ni-Vee bronzes are produced by authorized foundries in industrial areas from coast to coast.

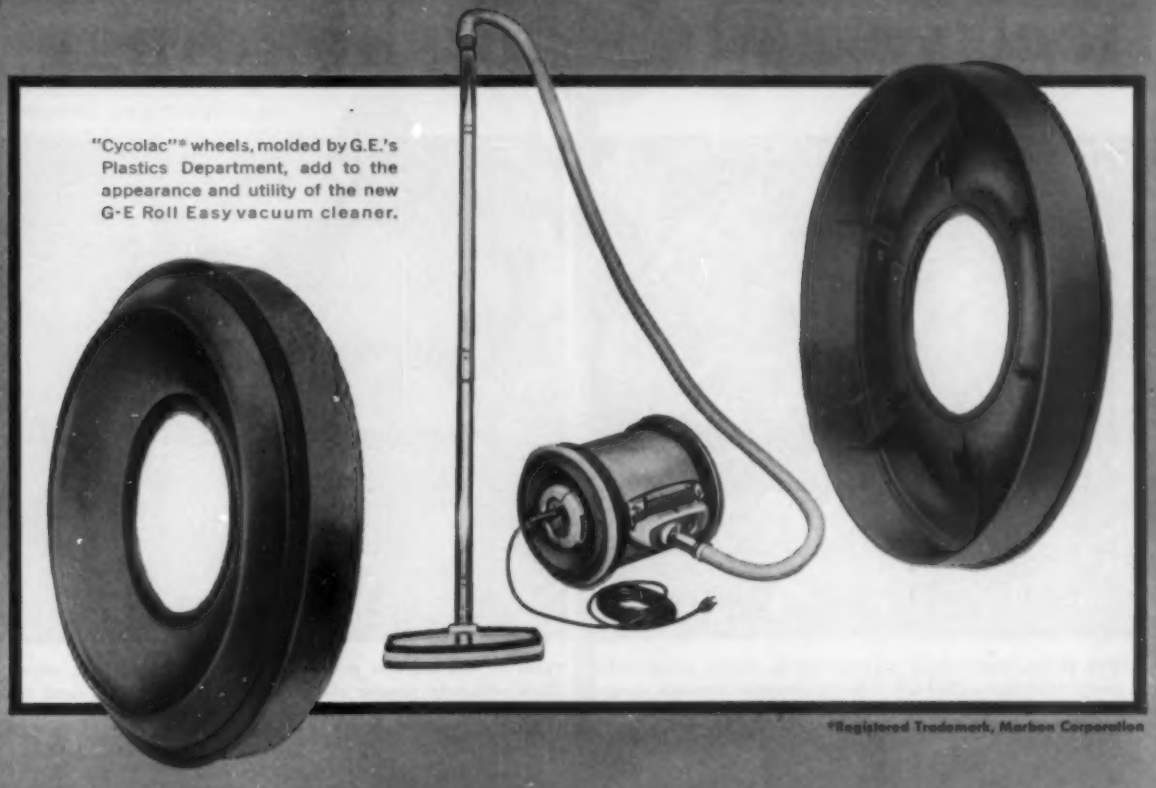
Get the facts about nickel-tin bronzes and see how they can save you money. Write now for the valuable data-packed booklets entitled, "THE NI-VEE BRONZES." They are yours for the asking.

Four times life of replaced tin bronze and still good. That's the status of Ni-Vee bronze feed screw nuts cast by A. W. Cadman Mfg. Co., for Babcock & Wilcox, Beaver Falls, Pa.

2,000,000 tons of steel were rolled by a 40" blooming mill, before its Ni-Vee bronze screw box nuts . . . such as the one shown above . . . called for replacement.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

Another new product... made better with parts molded by G.E.'s Plastics Department



"Cycolac"* wheels, molded by G.E.'s Plastics Department, add to the appearance and utility of the new G-E Roll Easy vacuum cleaner.

*Registered Trademark, Marbon Corporation

DESIGNING A NEW PRODUCT? Perhaps plastics parts by G.E. can help—to make it better or at lower cost! For example, the plastics wheels for G.E.'s new Roll Easy vacuum cleaner had to be tough enough to act as their own bearing surface, have sufficient stability to compensate for thermal variances, and be able to take rough household handling. G-E Plastics Department engineers specified "Cycolac"—and devised special techniques to obtain optimum performance.

RESULT? Another new product—produced more quickly and economically—with better appearance for increased buyer acceptance!

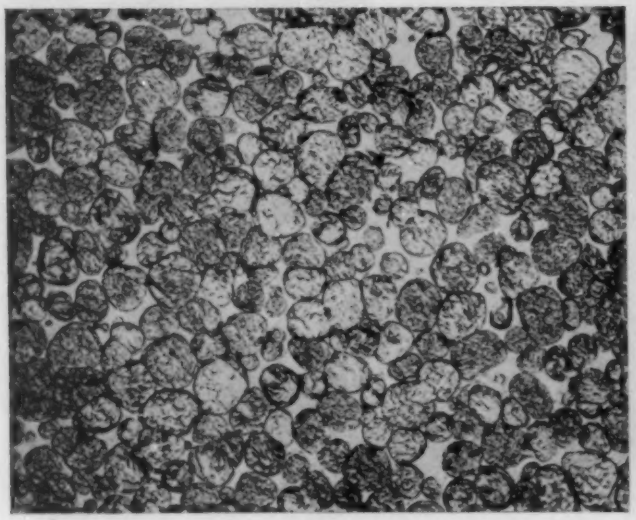
Have YOU a job for plastics? Then let G-E plastics engineers preview it with you—with an eye toward cost-cutting, performance-improving contributions—made at the very start!

Write: Plastics Department, General Electric Company, Pittsfield, Mass.
Plants at Decatur, Illinois—Taunton, Massachusetts 550-5B

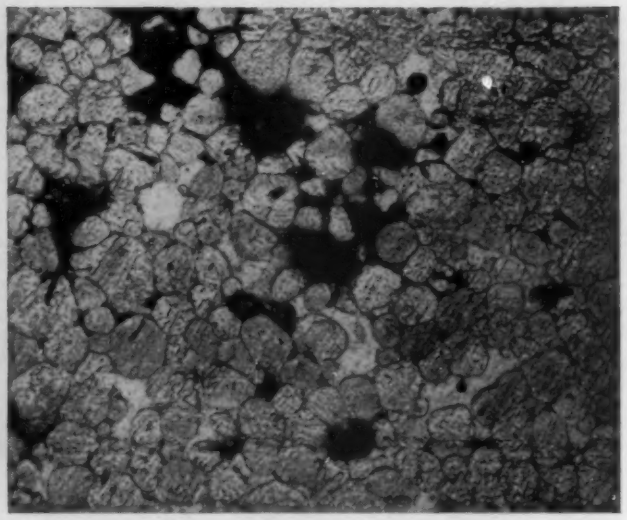
Progress Is Our Most Important Product

GENERAL ELECTRIC

Uniform Structure
of Mallory 1000 Metal assures effective radiation shielding



Mallory 1000 Metal, under high magnification, shows completely uniform grain structure. Its high density extends through every part of the piece . . . free from voids and weak spots.

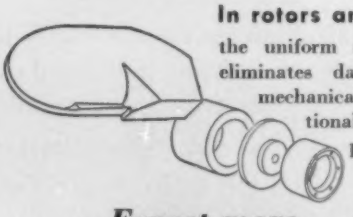


Voids in less uniform metals look like this under the microscope. They seriously impair shielding effectiveness and tend to make performance unpredictable.

WHEN you design radiation shields with Mallory 1000 Metal, you can figure on the basis of *accurate* characteristics . . . instead of having to estimate on "typical" values. You can predict performance of your design precisely, because every piece of Mallory 1000 is produced to the same, precisely controlled qualities . . . and, most important, these qualities are completely uniform *throughout each piece* of the metal.

Up to 40% more effective than lead, Mallory 1000 is being used for shielding at energy levels up to 100 MEV. It has excellent weathering qualities, and machines to a high surface finish. Intricate shapes are produced economically to accurate tolerances by exclusive Mallory contour pressing methods. For complete data, write to Mallory for Technical Bulletin 6-7.

Typical source capsules made of Mallory 1000 provide "leakproof" shielding.



In rotors and counterweights, the uniform structure of Mallory 1000 eliminates danger of unbalance. High mechanical strength, density and rotational inertia make possible smaller parts, faster rotational speeds.

In Canada made and sold by Johnson Matthey & Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Expect more . . . Get more from

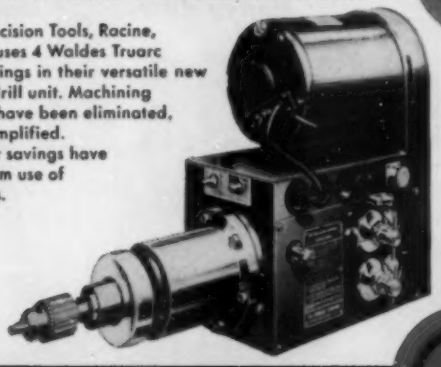
P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

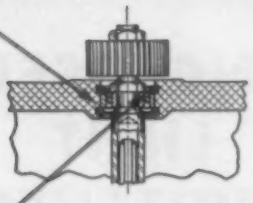
4 Waldes Truarc Rings Cut Costs Drastically, Increase Versatility of Precision Automatic Drill

Dumore's New Automatic Drill

Dumore Precision Tools, Racine, Wisconsin, uses 4 Waldes Truarc Retaining Rings in their versatile new automatic drill unit. Machining operations have been eliminated, assembly simplified. Great labor savings have resulted from use of Truarc rings.

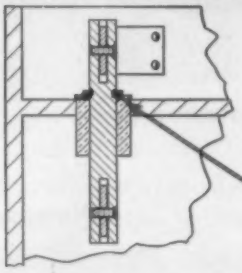


Drive Spindle Assembly



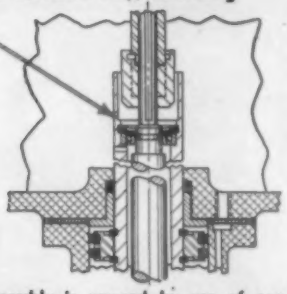
Bearing is held in position by two Waldes Truarc Rings—Standard (Series 5000) and Bowed (Series 5001). Two grooves are turned and housing rough bored in one operation. Alternate method would require at least two additional machining operations. Bowed Truarc ring takes up accumulated tolerances resiliently.

Actuator Lever Shaft Assembly



A Single Waldes Truarc External Retaining Ring (Series 5100) acts as shoulder, holds the lever in position. Labor savings are tremendous—a simple groove cutting operation replaces turning a shoulder, grinding and polishing.

Piston Assembly



Easy assembly is assured by use of one Waldes Truarc Bowed Ring (Series 5001) to lock the bearing to the piston assembly. When unit is to be used in tapping applications, entire spindle assembly can be removed without disassembly.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

*Name*_____
*Title*_____
*Company*_____
*Business Address*_____
*City*_____ *Zone*____ *State*_____

PN 117

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

Does YOUR design

Let MICRO SWITCH Engineering help you select

ENCLOSED LIMIT SWITCHES

Heavy duty

Explosion-proof

Small 2-circuit

Roller arm sealed plunger

Roller arm explosion-proof

Plunger actuated

Hand operated

Roller plunger operated

Sealed plunger

Send for new Catalog 83 for complete description of a wide variety of enclosed switches for industrial use.

call for an enclosed switch?

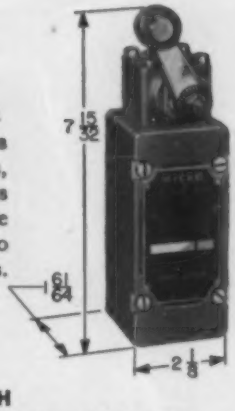
the precision switch for your application!

MICRO SWITCH enclosed precision switches afford the design engineer a wide choice of types to meet most exacting requirements. Shown here are a few of the many types of MICRO SWITCH enclosed switches. They are available in a wide variety of circuit arrangements and actuating mechanisms.

Is your equipment to work in atmospheres laden with dust, dirt, moisture or abrasives? MICRO SWITCH provides both general purpose and limit switches sealed so as to be unaffected. Explosion-proof switches for hazardous atmospheres and splash-proof switches for conditions of extreme moisture may meet your design problem. Two decades of experience in meeting industrial precision switch problems is as close as your telephone.

MICRO SWITCH branch offices are located in 22 principal cities. These offices are staffed by factory-trained, experienced personnel. Their experience in solving every type of switching problem is available to you. A call may save you time and money by bringing a quick solution to YOUR design problem.

SMALL 2-CIRCUIT LIMIT SWITCH
For control of two independent circuits. Sealed construction, high electrical capacity and features of adjustability suit it to all types of industrial applications where space is limited.

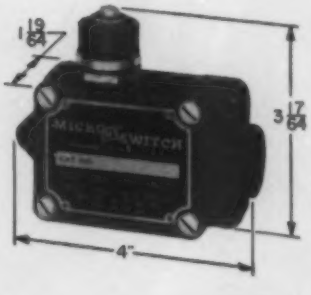


EXPLOSION-PROOF LIMIT SWITCH
Suitable for use in hazardous atmospheres such as are present in chemical factories, refineries, flour mills, paint spray booths and metal processing plants. Available with roller arm actuator (shown). Also with pin and roller plunger actuators.

COMPLETELY SEALED CYLINDRICAL SWITCH

Developed for aircraft designs, this switch has greater versatility than switches many times its weight and size. Two single-pole, double-throw switching units are completely sealed in a housing filled with inert gas under pressure.

HIGH CAPACITY SWITCHES
Long-life precision switches will make and break steady state currents of 20 amperes and switch inrush currents as high as 75 amperes. Shown with sealed plunger actuator for in-line operation. Also available with roller arm actuators.



A complete line of snap-action and mercury switches

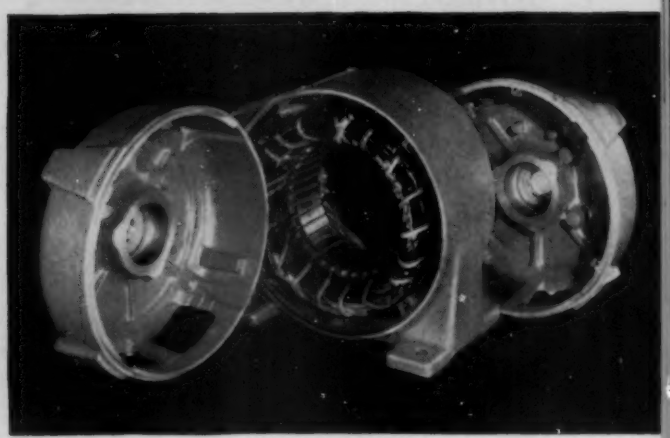
MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

MOTOR FACTS ON INDUSTRY'S
MOST-PREFERRED "POWER PACKAGE."



Electrical System Fact: New fortified insulation includes exclusive Bondar, Bondite and Mylar* for greater protection against the toughest operating conditions.

*Du Pont registered trade-mark

FACT:

The new Life-Line A has stronger insulation than any other motor on the market

Meaning what? Simply that the new Westinghouse Life-Line® "A" motor with new fortified insulation can withstand heavier overloads and operate at higher temperatures than any other motor you can buy.

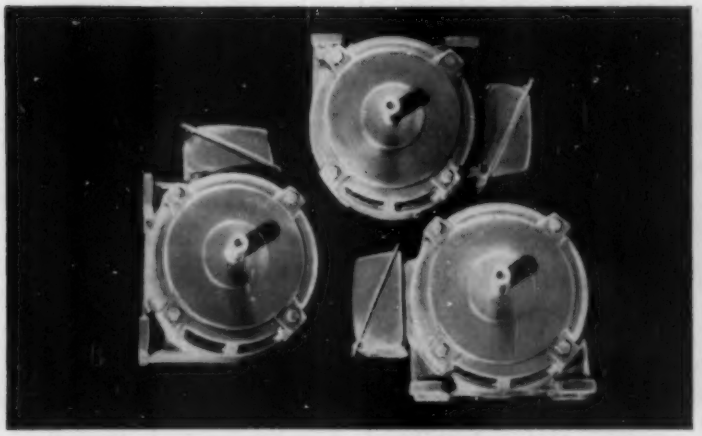
Similar design advances in the mechanical and lubrication systems make Life-Line "A" industry's most preferred motor.

It takes the right combination of *all three systems*—electrical, mechanical and lubrication—to build the best package of power on the market.

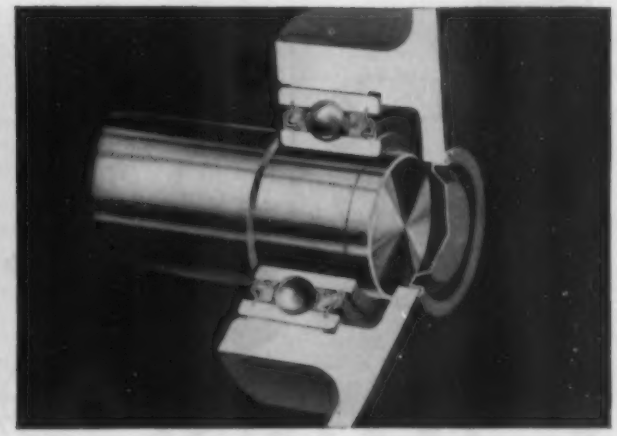
Get all the facts by calling your Westinghouse sales engineer . . . *The Man With The Facts!*

J-21877

YOU CAN BE SURE...IF IT'S Westinghouse



Mechanical System Fact: New cast-iron housing on both drip-proof and totally-enclosed types. Ventilation openings only in end brackets make the motor drip-proof whether mounted on floor, ceiling or wall.



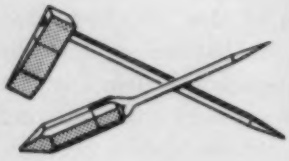
Lubrication System Fact: New "4-way sealed", pre-lubricated bearing eliminates completely the 3 main causes of bearing failure: 1) contamination, 2) over greasing, 3) wrong grease.

ITEMS LIKE THESE AVAILABLE AT

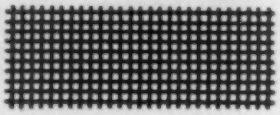
Chase® WAREHOUSES!

BRASS or COPPER RIVETS and WASHERS

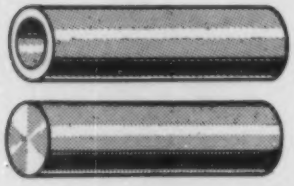
BRASS, COPPER, BRONZE COTTER PINS



SOLDERING COPPERS



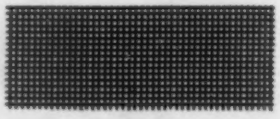
INDUSTRIAL WIRE CLOTH



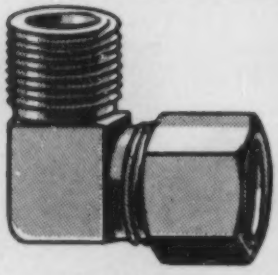
SOLID or CORED BEARING BRONZE

BRASS or BRONZE WOOD and MACHINE SCREWS

BRASS ESCUTCHEON PINS



BRASS STRAINER CLOTH



INDUSTRIAL and AUTOMOTIVE FITTINGS

BRASS or BRONZE BOLTS and NUTS

CALL US FOR ANYTHING from Bearing Bronze Bars to Brass or Bronze Bolts... or other fastenings like those shown here for maintenance, repair, operating or production. Twenty-five Chase warehouses are located in major industrial centers from coast to coast. Phone the one nearest you. We can usually fill your orders from stock.

NEW! Chase's informative rod and wire movie: "IN THE CHIPS." Arrange for a free loan of this film by contacting the Chase warehouse or sales office near you. Write on your company letterhead, today!

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Atlanta Baltimore Boston Charlotte† Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids† Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester† St. Louis San Francisco Seattle Waterbury (†sales office only)

ONE OF A SERIES

You Get Many Benefits by Specifying VICKERS® Hydraulics

service
repair parts
replacement equipment

Within Easy Reach of Your Export Customers

Mindful of the fact that capital goods (much of which is Vickers equipped) constitutes 25% of U.S. non-military exports, Vickers is actively building up its export representation. In the panel at the right, are listed the organizations which represent Vickers abroad.

Each of these is equipped to supply engineering information, service, parts, and replacement equipment for the Vickers Hydraulics on the machine tools, industrial machinery and mobile equipment you send abroad. This added convenience is important to your customers . . . hence an important sales factor in your export business.

This is another way in which you get added value when you specify and buy Vickers Hydraulic Equipment.

•

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:

ATLANTA (ATwood 0187) • CHICAGO (HUnter 5-0300) CINCINNATI (MAin 1-1756) • CLEVELAND (SUperior 1-4638) • DETROIT (DIamond 1-0990) • HOUSTON (JAckson 2-9623) • LOS ANGELES AREA (El Segundo—ORegon 8-2503) • MINNEAPOLIS (GEneva 5646) • NEW YORK AREA (Summit, N. J.—SUmmit 6-7960) PHILADELPHIA AREA (Media—MEdia 6-5300) PITTSBURGH AREA (Mt. Lebanon—LOcust 1-3504) PORTLAND, OREGON (FIlmore 9446) • ROCHESTER (LOcust 5384) • ROCKFORD (2-0615) • SAN FRANCISCO AREA (Berkeley—AShberry 3-4997) • SEATTLE (SEneca 8171) • ST. LOUIS (PArkview 1-4311) • TULSA (DIamond 3-8655) • WASHINGTON (EXecutive 3-2650) WORCESTER (PLeasant 3-7736—6-5281)

IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

VICKERS Export Representation

AUSTRALIA
Industrial Service Engineers Pty., Ltd.
Ashley Street, Braybrook W. 19
Melbourne, Victoria

•

BELGIUM
Fenwick (S.A.) Belge
68 Quai de Rome
Liege, Belgium

•

CANADA
Vickers-Sperry of Canada Ltd.
156 Evans Avenue
Toronto 14, Ontario

•

DENMARK
Akts. Nordisk Venditor
14, Tordenskjoldsgade
Copenhagen K, Denmark

•

ENGLAND
Stein & Atkinson, Ltd.
Universal House
60 Buckingham Palace Rd.
London, S.W.1, England

•

FINLAND
Ins. Isto. H. Auramo
Fabianinkatu 13
Helsinki, Finland

•

FRANCE
Fenwick S.A.
8 Rue de Rocroy
Paris 10e France

HAWAII
Hawaiian Equipment Co.
2880 Kilihau Street
P. O. Box 2990
Honolulu 2, Hawaii

•

ITALY
Societa Fenwick
Viale Vittorio Veneto, 16
Milan, Italy

•

JAPAN
Tokyo Keiki Seizosho Co., Ltd.
31, 4 Chome, Higashi-Kamata
Ōta-Ku, Tokyo, Japan

•

NORWAY
Venditor A/S
Post Office Box 127
Ski, Norway

•

SOUTH AFRICA
Hydraulics (S.A.) Ltd.
P. O. Box 111
Paarden Eiland
Capetown C.P., So. Africa

•

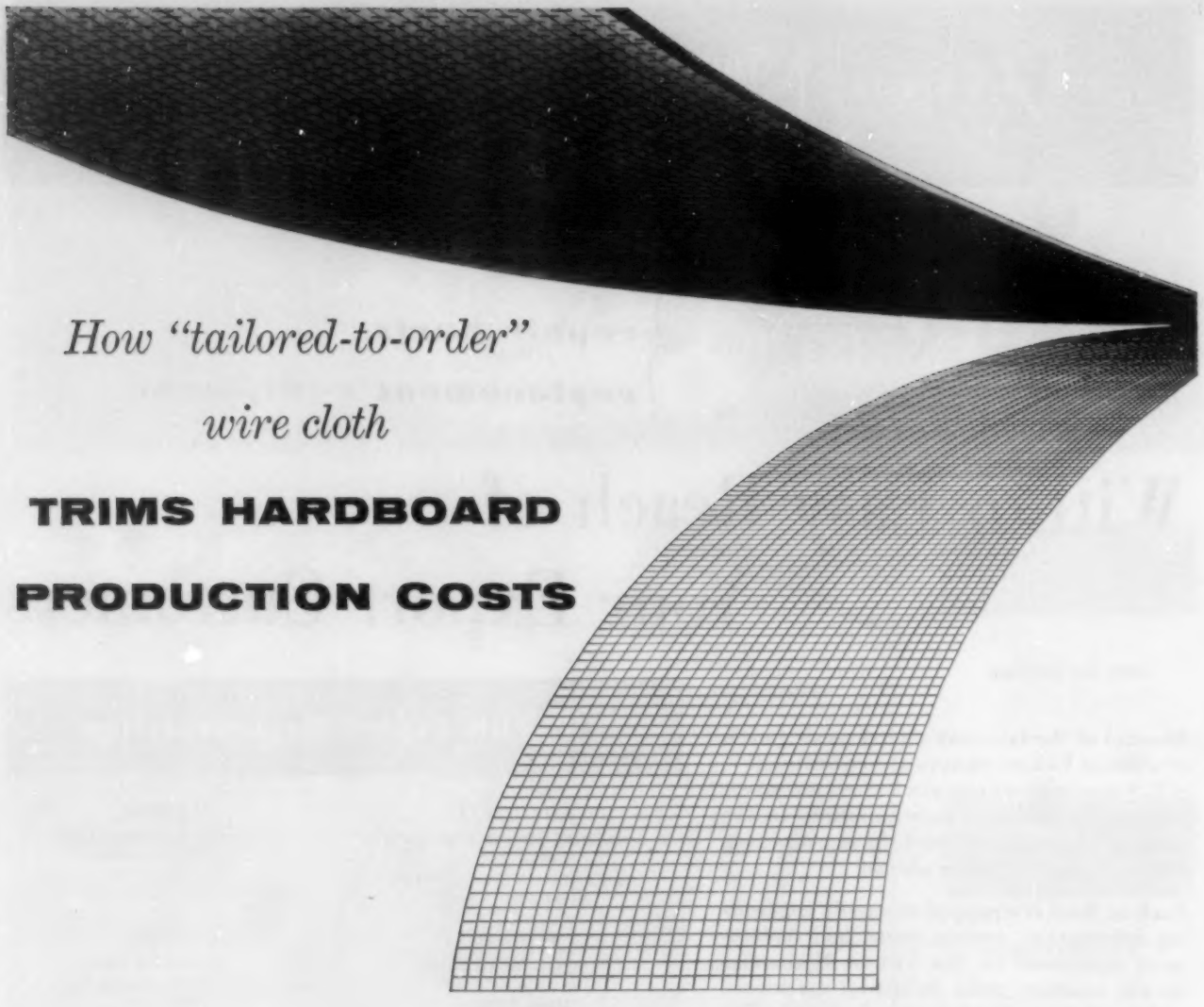
SPAIN
S.A.M. Fenwick
Bruch 96
Barcelona, Spain

•

SWEDEN
AB Specialpumpar
Goteborg, Sweden

7302

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



How "tailored-to-order" wire cloth

TRIMS HARDBOARD PRODUCTION COSTS

• There's a tell-tale pattern on the back of a leading brand of hardboard. It was left there by a *new* kind of wire cloth, developed by the *Reynolds Wire Division* of National-Standard—developed because their customer had a problem which, as usual, Reynolds solved.

In this hardboard manufacture, wire cloth carries the heavy wet compound, supports the material during pressing, and pulls out the hardened boards, while being stripped away from the big boards by force. The stress is terrific! In fact there *was* no wire cloth that would hold up. It failed too often, requiring frequent replacement, slowing production and adding to costs.

But now all that is past . . . because Reynolds tackled the problem and came up with a radically new cloth construction. So unusual was the cloth that Reynolds even had to build special looms to produce it.

Here again is an example of the lengths to which Reynolds *often* goes to help customers save money, produce better products, or both! But problem or no problem, if you *use* wire cloth, or want to check on its use, you'll find Reynolds' kind of service and cooperation always pays off. Try us and see.

NS NATIONAL-STANDARD Company NILES, MICHIGAN

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape
ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel
REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth
WAGNER LITHO MACHINERY DIVISION • JERSEY CITY, N. J.
Special Machinery for Metal Decorating
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

9 design problems that can be met with the... Allenut

Ever-increasing applications for the new ALLENUT have caused sales to double within the past two years. Here are some of the things it can do to aid your product designing:

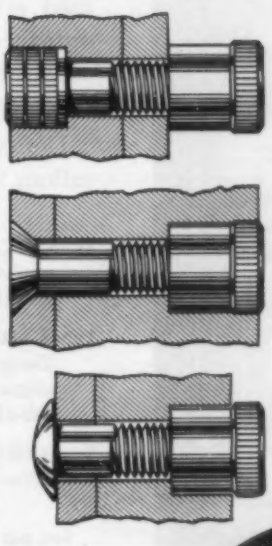
1. Self-anchoring in any metal. Allenut provides positive anchoring action through its hardened knurls.

2. Compact design. Requires no space for box wrenching. 12-point socket permits tightening in awkward places.

3. Smooth surfaces. Fits flush or below surface in counterbored hole . . . permits streamlined, safe surfaces.

4. A ready-made, hardened, tapped hole. When used as a bushing, prevents costly stripping of threads caused by frequent removal and replacement of screw or bolt. In castings and other soft metals a stripped hole can be counterbored, an Allenut inserted and the same bolt or screw used.

5. Tighter fit. Greater thread contact than with ordinary nuts because of Class 3 fit. Weld-like setups accomplished with one hand wrenching. Allenut holds firm against turn of screw.



6. Usable with any type of bolt or screw. Permits space-saving, internal wrenching of cap screws, T bolts, machine bolts, and other common fasteners.

7. Saves parts. No washers required when anchored.

8. Easier to use. Knurled ring facilitates fingering-in. Allenut is always square to counterbored hole. Removable by hitting screw or bolt head with tap of a hammer.

9. Reusable indefinitely. Anchoring action remains unimpaired. Hardened threads and socket stand up under repeated removal and replacement.

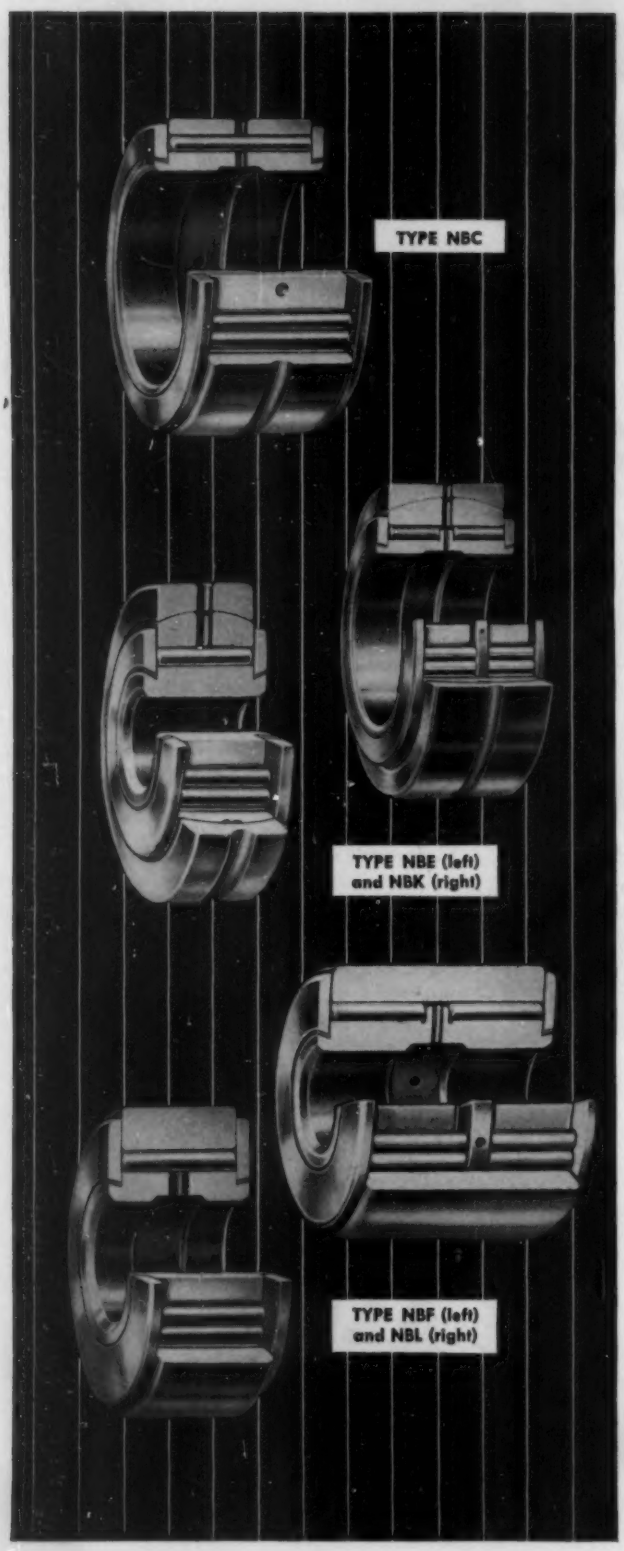
Allenuts are available in a full range of 14 standard sizes from no. 4 to 1" from leading industrial distributors.

We welcome your inquiry and request for engineering details on Allenut applications.

TORRINGTON

NB SERIES NEEDLE BEARINGS

For Oscillating Motion or Heavy Rolling Loads



Torrington NB Series Needle Bearings employ the same needle roller principle as the famous DC Type Bearing.

They are available in the five types illustrated, all being of nonseparable construction and designed for periodic relubrication. Outer and inner races are of high carbon, chrome steel, hardened and precision ground.

Like the DC Type, the compact design of NB Series Needle Bearings permits saving in size and weight of surrounding parts.

Torrington NB Series Needle Bearings have been used extensively in the aircraft industry and for ordnance work where their extremely high static capacity and anti-friction characteristics enable them to withstand heavy impact loads.

Designs can be modified to meet industrial applications involving rotating motion.

Type NBC—oscillating motion only. Designed specifically for applications in which the OD is supported by a housing and the washers are backed up by clamping surfaces.

Types NBE and NBK—oscillating motion only. Self-aligning. Designed for applications where it is difficult to obtain alignment during assembly or where deflections make a self-aligning bearing desirable.

Types NBF and NBL—heavy rolling loads. Designed for use as rollers under heavy loads at slow speeds.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

THE TORRINGTON COMPANY

Torrington, Conn. South Bend 21, Ind.

District offices and distributors in principal cities of United States and Canada

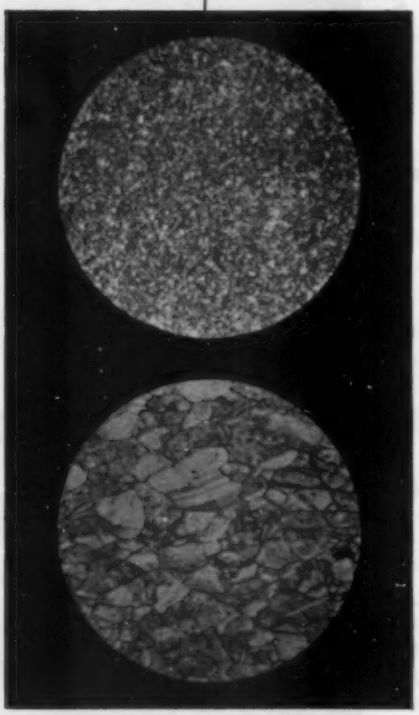
TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller Ball • Needle Rollers

DURAFLEX . . .

a NEW fine-grain phosphor bronze with 30% GREATER ENDURANCE LIMIT

FINE-GRAIN STRUCTURE IS THE MAIN REASON . . .



Micrographs (75x magnification) tell the inside story. Top, note the fine-grain structure of DURAFLEX. Compare it with the grain structure of ordinary phosphor bronze, bottom.

DURAFLEX* is a new, fine-grain phosphor bronze developed and sold only by Anaconda. Comparative fatigue tests show that the endurance limit of DURAFLEX is approximately 30% higher than for ordinary phosphor bronzes. In surface appearance, surface smoothness and resistance to corrosion, it is equal to, or better than, other phosphor bronzes. Further, its formability is increased with no sacrifice in yield strength. DURAFLEX is a *premium* phosphor bronze in every way except cost; there's *no increase in price.*

If you're now using a hard-temper phosphor bronze, chances are that you can do the same forming in extra-hard temper DURAFLEX. If you're looking for longer life in the parts you form, we'll be glad to send you a free sample of DURAFLEX. Try it, test it, and you will agree that it's superior.

5576 *Trade-Mark

DURAFLEX fine-grain phosphor bronze

an ANACONDA® product

MADE BY THE AMERICAN BRASS COMPANY

Try a FREE SAMPLE of

DURAFLEX

Sheet . . . up to 0.062" thick
Wire . . . up to 3/16" diameter (approx.)

FREE SAMPLE

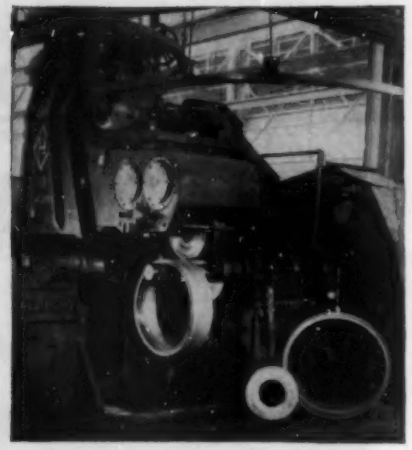
The American Brass Company, Waterbury 20, Connecticut
(In Canada: Anaconda American Brass Ltd., New Toronto, Ontario)

Yes, we'd like to try DURAFLEX. Please send us a free sample of
sheet in _____ temper, _____ thick,
wire in _____ temper, _____ diameter.
☐ We'd like to talk to one of your metallurgists about DURAFLEX.

NAME.....
COMPANY.....
STREET.....
CITY.....ZONE....STATE.....

(Advertisement)

8 RECENT DEVELOPMENTS TO BRING YOU UP TO DATE ON ALCOA® ALUMINUM FORGINGS



Forged aluminum rings—iron out many production wrinkles.

HERE'S WHEN IT WILL PAY YOU TO SET YOUR SIGHTS ON ALUMINUM FORGINGS

How long has it been since you really re-examined the possibilities of aluminum forgings for your particular design problems? That's a loaded question—because even if you said, "a month ago," we'd tell you to take another look. That's how fast things are happening.

The basic principles don't change much, of course. Aluminum forgings still are a natural choice when any of the following apply:

1. Weight reduction—you can figure on saving up to two thirds.
2. Strength—a forged aluminum part provides the added strength so essential in some parts, such as airframes.
3. Surface quality and finish—of aluminum forgings offer greater smoothness and freedom from laps, greatly reducing the need for finish-machining operations.
4. Dimensional uniformity—also reduces finish-machining to a minimum, and permits designing of thinner sections to closer tolerances, with important savings in weight.

The changes we want to talk about are merely a matter of the degree to which these ground rules apply. Let's take a couple of "for instances:"

ROLLED RINGS

Did you know we've been rolling forged rings in any of the standard forging alloys and tempers, using a specially designed forging machine, in the following sizes:

	Maximum	Minimum
Outside Diameter	40″	12″
Inside Diameter	38″	10″
Length	18″	4″

We're even beginning to get some experience on contour rolling—and while we're not able to offer any and every shape, it might pay you to talk over your requirements with our engineers.

We also invite your inquiries on rolled rings in AM65S, AMC57S, AMC58S and AMA76S magnesium alloys.

WHY FORGE ON A HYDRAULIC PRESS?

When it comes to the really big stuff, we think hydraulic presses may be your best bet—especially if weight reduction and a minimum of machining are critical with you. And we have some of the biggest and best hydraulic presses in the business. The two biggest in our Cleveland plant, for example, rated at 50,000 tons and 35,000 tons, can make forgings having a plan area of up to 5,000 square inches. That's pretty fair sized, when you stop to think that a typical airframe fitting has had a plan area of 1,500 or 2,000 square inches.

This ability to make bigger forgings is not the whole story, however.

50,000 and 35,000-ton hydraulic forging presses—two of the biggest in the business, at Alcoa's Cleveland plant.

There's an inherent advantage in the way the thing works: one stroke and you're done. The single stroke of a hydraulic press and the ability to use knockouts permit the reduction of draft angles from the customary 5°-7° of hammer forgings down to 1°, or less, in some cases—and it minimizes

MECHANICAL PROPERTIES SPECIFICATION, X7079

(Section thickness up to six inches, heat-treated at mill)

HAND FORGINGS

	LONGITUDINAL			LONG TRANSVERSE			SHORT TRANSVERSE		
	Tens. Str. ksi	Yield Str. ksi	El % in 4D	Tens. Str. ksi	Yield Str. ksi	El % in 4D	Tens. Str. ksi	Yield Str. ksi	El % in 4D
Guaranteed minimum	73	62	9.0	70	60	6.0	65	54	4.0
Typical	77	67	13.0	73	63	9.0	71	59	6.0

DIE FORGINGS

AXIS OF TEST SPECIMEN	GUARANTEED MINIMUM			TYPICAL		
	Tens. Str. ksi	Yield Str. ksi	El % in 4D	Tens. Str. ksi	Yield Str. ksi	El % in 4D
Parallel to forging flow lines	74	64	10.0	78	68	14.0
Other than parallel to forging flow lines	72	61	4.0	76	66	9.0

"New Aluminum Alloy Developments" by W. D. Stewart.

the slivers and abrasions of repeated hammer blows. Result: less weight, less machining. What's more, because of the slower action and higher die temperatures possible with a single stroke, thinner web sections are possible, and because of the resulting better metal flow, punch-outs present additional opportunities for weight reduction. Surface quality is better, too—with greater smoothness and freedom from laps, folds or other defects. And slower metal movement lets us flow metal around the corners of a die more readily than on a hammer. That could mean smaller fillet radii—and further weight reduction.

WHAT'S NEW WITH ALLOYS?

First, there's a new high-strength alloy, X7079. It's of the aluminum-zinc-magnesium-copper type—on the same family tree as 7075. But look at the chart. You'll find some distinct mechanical advantages. It's less quench sensitive—and provides a higher level of short transverse elongation. We think it's going to be less apt to distort on machining, too. If you're machining large hand forgings and die forgings, that ought to be pretty interesting. Let us know and we'll see you get the complete dope.

Then there's X2219—a new elevated, temperature-wrought alloy of the aluminum-copper type, containing small additions of manganese, vanadium and zirconium. It offers substantial advantages in tensile strength for operation in the 500-600°F temperature range. We think it has possibilities on almost any application—engine, aircraft or pressure vessel—in that range. We hope you'll think so, too.

And here's a new magnesium alloy for forgings—AMA76S-T5. Its yield strength is slightly lower than AMC58S-T5; but its elongation is considerably higher. It's easier to forge—but it is not recommended for use where the operating temperature exceeds about 180°F under load. Here's an alloy with a tougher, readily worked composition, almost as strong as AMC58S, the strongest of the magnesium alloys previously available for forgings. Does that give you ideas?

YOU SAY YOU WANT TO SAVE WEIGHT?

Here's an example of how an aluminum forging cut—almost in half—the load a lineman or lumberjack has to carry: the shank on a pole climber. In steel, it would weigh eight pounds; in aluminum, it's a little over four pounds, yet just as strong as steel. Finish is better, too—and with a dimensional stability that permits the addition of an extruded aluminum oval sleeve, sliding over the forged shank to provide adjustment for length.

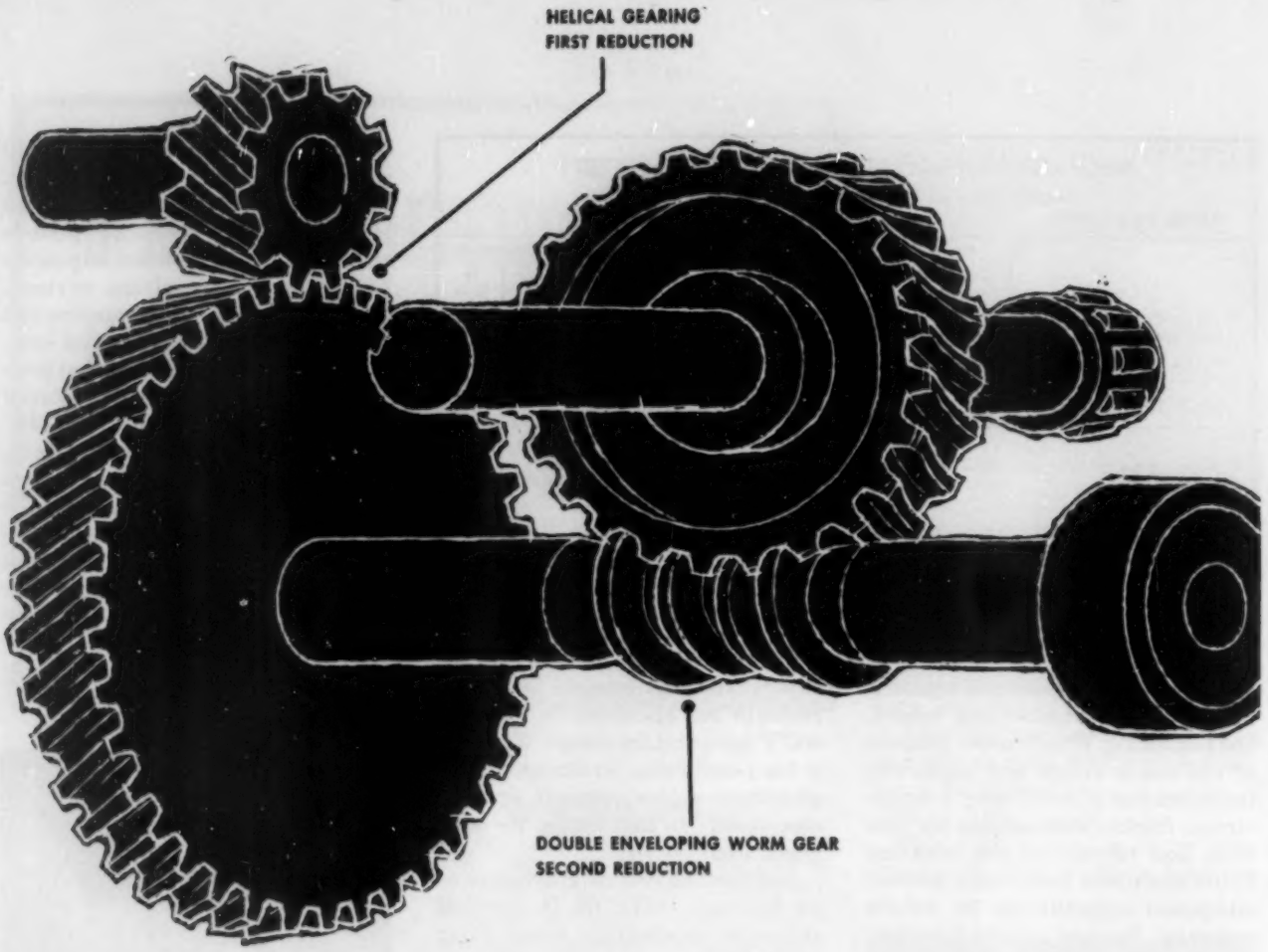
And here's another example of cutting weight in half: a tandem axle beam (equalizer beam) of a bogie to cut road shocks on truck trailers. In steel, this unsprung weight amounted to 120 pounds per beam (240 pounds per tandem); in aluminum, 60 pounds per beam. The resultant savings, 120 pounds, not only means less tire wear, less shock on chassis and load, but also a lower tare weight that pays off in increased revenue. These forged aluminum beams are fairly large (48" between center lines of the bosses on the two ends), designed to support a static load of 16,000 pounds at the center. Some have been in service a year—and we're turning them out at the rate of 1,000 a month. Better get on this band wagon—not only for your own trucks, but for the basic principle of weight saving they represent.

Weight cut almost in half—a pole climber that uses an aluminum forging and provides the plus feature of adjustable length, for greater comfort.

WHAT YOU CAN DO

If any of the foregoing has sparked an idea—or if you have any kind of a problem in aluminum forgings, big or small (parts *or* problems, we mean), call on Alcoa. To contribute solid technical thinking, at the design stage, your local Alcoa sales engineer is listed under "Aluminum" in your phone book. Use him. Aluminum Company of America, 1992-L Alcoa Bldg., Pittsburgh 19, Pa.

Your Guide to Aluminum Value



How Westinghouse new right-angle gearmotor delivers 32% more power

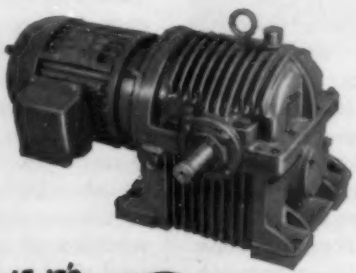
With this exclusive match of gearing, Westinghouse right-angle gearmotor gives you top horsepower and rugged dependability at the lowest cost. It's the result of skillful use of helical gearing to gain maximum efficiency from high lead-angle worm gearing. Over a range of speed reduction, from 20:1 to over 100:1, the Westinghouse right-angle gearmotor *averages* 32% more power than conventional single-reduction, worm gearmotors. At a ratio of 60:1 you actually get 98% more power.

Greater dependability and long life result from Westinghouse exclusive double-enveloping worm gear. It provides 330% more gear-tooth area to support the load. As wear occurs, only double-enveloping gears regenerate or reproduce themselves.

In application, Westinghouse design for high overhung load capacity requires no outboard support. Right-angle gearmotors are available in a complete range of AGMA output speeds and Life-Line® "A" motor enclosures.

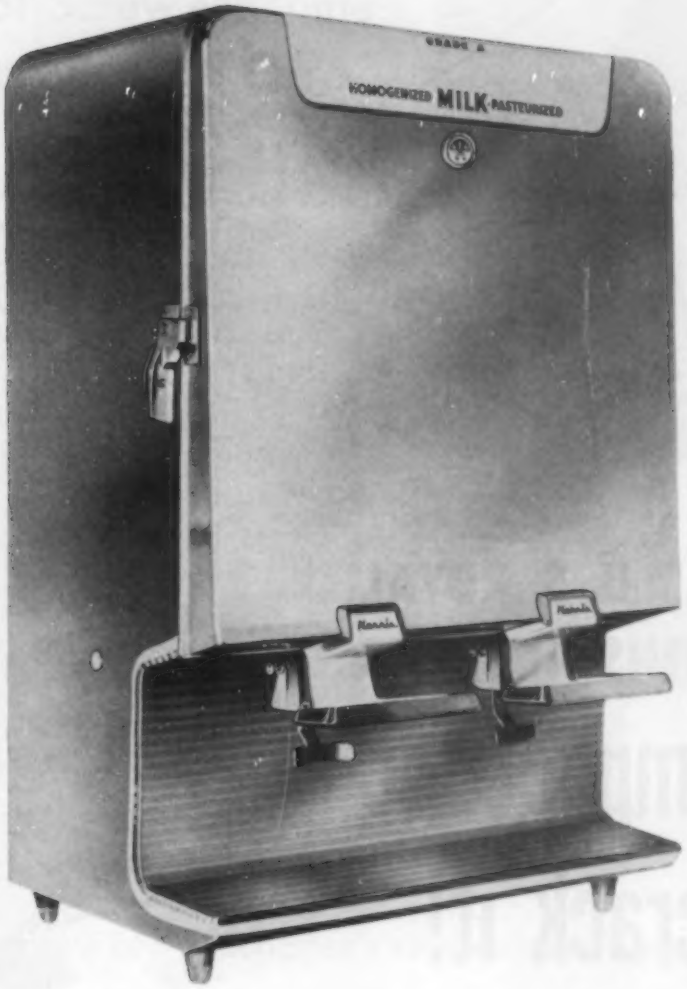
FREE detailed facts about Westinghouse new right-angle gearmotor in booklet B-6579. Call your local Westinghouse Sales Office or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

J-07349



YOU CAN BE SURE...IF IT'S

Westinghouse



this attractive new dispenser of STAINLESS STEEL

meets every standard for cleanliness and top design

The Norristocrat is the newest addition to the line of milk dispensers manufactured by Norris Dispensers, Inc., of Minneapolis, Minnesota. It's designed by Raymond Loewy Associates and, like many Norris dispensers, it's Crucible stainless steel *inside and out.*

INSIDE, it's stainless to keep milk dairy-fresh, with flavor unchanged . . . to make cleaning easier . . . to meet all sanitary codes . . . and to satisfy the most exacting demands of schools and hospitals across the nation.

OUTSIDE, it's stainless to insure an attractive, lasting appearance that complements its clean, modern design . . . and adds to its promotional effectiveness for encouraging the consumption of milk.

Cleanability, product protection and bright good looks are the main reasons Norris insists on stainless steel. But stainless offers many other properties, too — among them corrosion and heat resistance, high tensile strength, excellent workability. And you'll find exactly the combination and degree of these properties you need in one of the thirty grades of Crucible stainless steel. To see what general and technical literature is available to help you make the most of Crucible stainless — or any other Crucible special purpose steel — write for your free copy of the Crucible Publication Catalog. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

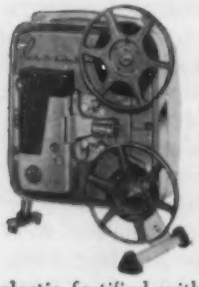
CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

U. S. ROYALITE WINS ANOTHER CASE!

"Impact" couldn't crack it!

Exhibit "A"—The ROYALITE case of the new Revere "777" 8 mm. portable projector, is cleverly designed by Revere Engineers as an integral part of the machine. The removable cover contains a ribbed inner liner to which is riveted a reel support, cord retainer and lock. Revere, a user of Royalite cases since 1949, has pioneered in engineering its products for functional beauty.



To win, time after time, in the trial of use and abuse, any "portable" must have an eye-appealing case that stands up under hard knocks. A case like that of the fine, precision-built "777" portable projector, *formed from* U. S. ROYALITE.

This tough, versatile fabricating material has the structural rigidity of plastic fortified with rubber for needed impact resistance.

Supplied as a thermoplastic sheet, it is easily formed to complicated shapes with sharp detail on low-cost tooling, and for limited runs or prototypes, dies can be quickly and inexpensively made of wood or resin as well as metal. Needed supports and dividers to receive accessory parts can be formed simultaneously with the case, saving assembly operations.

U. S. Royalite thermoplastic sheets can be obtained in attractive standard or special built-in colors with glossy-smooth or dull textures. Various degrees of rigidity are obtainable, as well as flame-resistant (self-extinguishing) material. Contact us at once to see how Royalite can be turned into cases or covers for *your product*... cases that combine beauty, utility, and economy as never before. United States Rubber Company, 2638 Pulaski Road, Chicago 39, Ill.

U.S. ROYALITE
TOUGH, VERSATILE FABRICATING MATERIAL

US RUBBER

United States Rubber

"Economical Buying of Screw Machine Products Now Calls for Greater Care in Specifications,"

says Leonard Schaffer, President, Mechanical Art Works, Inc., Newark, New Jersey

A few typical fine-finish, close tolerance screw machine products currently produced from ANACONDA Rods at the Mechanical Art Works.

"The tremendous versatility of automation in modern manufacturing has placed a bigger burden on the designer and buyer of screw machine parts," Mr. Schaffer explains. "The trend toward miniaturization has shifted many more parts to the screw machine. And the screw machine's ability to provide *tolerances* as close as .0005", and finishes heretofore obtainable only by centerless grinding, has left a tremendously wide choice in specifications."

Mr. Schaffer, a long-time user of Anaconda products, says, "I can count on the uniform machining characteristics of ANACONDA Rods from batch to batch, which is important for both quality and economy in my business."

For complete data on composition and machinability of standard ANACONDA Alloys, standard specifications, weights and dimensions of standard rods, write for Publication B-14. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5383

A few of Mr. Schaffer's suggestions to buyers of screw machine products for keeping costs down.

Wherever possible, the largest diameter of the piece should correspond to a standard stock rod diameter.

Avoid fancy shapes calling for expensive forming tools.

Use hole diameters obtainable with standard tools.

Allow commercial tolerances if possible, otherwise specify tolerances no closer than necessary.

Specify Standard National Coarse or National Fine Threads wherever possible.

On external threads, cutting full threads close to a shoulder is expensive —and may be unnecessary.

Tapping blind holes close to the bottom is difficult and costly.

Specify free cutting material unless special physical properties are required, then select the best machining material containing those properties.

ANACONDA® RODS FOR SCREW MACHINE PRODUCTS

—This is the Anscoflash Type I flash attachment

...The secret behind its compactness is this

plastic housing custom molded by Sylvania

THE Anscoflash Type I is a highly compact flash attachment offering the camera fan an economical entry into the field of "flash" picture taking.

To achieve this compactness and economy Ansco designed a unique plastic housing . . . one which would serve both as a reflector base and battery case.

All parts of the Anscoflash Type I are in some way fastened to this plastic housing. That made design of this part complicated and the important question where to get *complete follow through* on such a complex injection molding. Ansco found the answer at Sylvania. That's because Sylvania offers complete "one source" service in custom molding of both thermoplastic and thermosetting materials.

Here's the important point we want to make: However simple or complex your plastic parts, we'd like to make these same facilities available to you. They include an experienced design and engineering staff—expert mold makers—modern automatic molding equipment—metal stamping and forming—and complete assembly if your part requires metal inserts or additions.

Let us meet with you and discuss your next custom-molded plastic parts job. Phone or write Dept. L 33S.

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 21

Hydraulic Tool "Winterized" With Dow Corning 200 Fluid

The instability of most fluids has been the limiting factor in designing compact hydraulic systems or hydraulic devices exposed to even seasonal changes in temperature. During the past decade, the accuracy and usefulness of hydraulic devices has been greatly increased through the use of Dow Corning 200 Fluids with their incomparably flat viscosity-temperature slopes. Here's a new example of product improvement through the use of silicone fluids.

For splicing electrical high lines, Burndy Engineering Co., Norwalk, Conn., manufactures a portable hydraulic tool called the "Hypress". This compact device weighs only nine pounds but develops a force of 18,000 pounds.

Although widely accepted by utility companies, the usefulness of the Hypress was

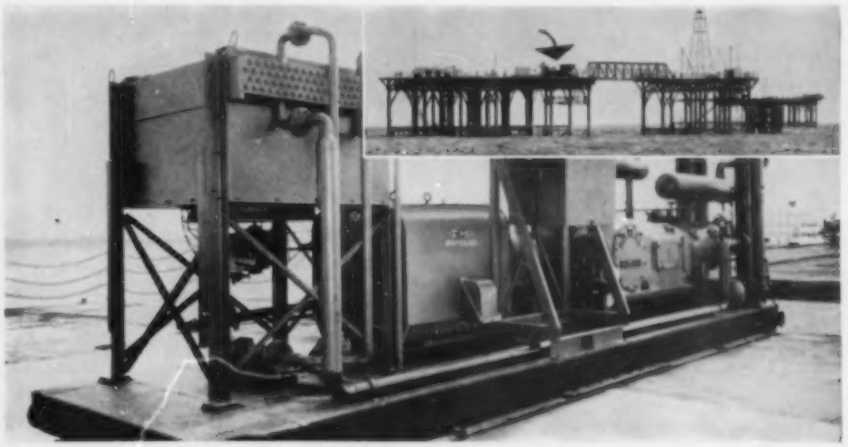
(continued pg 2)

Pressure Sensitive Silicone Tape 'Welds' Seam in Hot Water Heater

New opportunities for product improvement and production economies have been opened up by the introduction of heat-stable, waterproof tapes made with pressure sensitive Dow Corning Adhesives. Such tape forms a water resistant seal that retains adhesive strength at temperatures from —100 to 550 F. Here's how White Products Corp., Middleville, Mich., replaced a welded joint; saved production time and cut unit costs with such tape.

A leading producer of hot water heaters, White frequently found it necessary to

(continued pg 2)



Silicone Insulation Eliminates Need for TEFC Motors in Tidelands Oil Operations; Saves $3,000 per Unit!

In the dark ages before silicone insulation was developed, it was standard practice to specify TEFC motors in outdoor installations where excessive moisture, weathering or corrosive chemicals limit service life. Now progressive engineers are finding that open-type motors insulated with Dow Corning Silicones are equally effective and substantially less expensive.

A typical example of good modern practice is the silicone insulated compressor motor operating on one of the California Company's fixed oil well platforms in the Gulf of Mexico. Built by Electric Machinery Mfg. Co., Minneapolis, this 300 hp, 900 rpm induction motor is exposed to the most severe weather the Gulf can produce. Installed 10 months ago, the unit is in excellent operating condition.

The windings of this "Sil-Clad" motor are insulated with Dow Corning silicone resins, silicone resin-impregnated components, and a tape made with Silastic*, Dow Corning's silicone rubber. Outer protection is provided by a steel housing with a baffled ventilating system that prevents dust, moisture and chemicals from lodging in the motor. The housing and motor frame are coated inside and out with a silicone based paint formulated by Midland Industrial Finishes Co.

According to Electric Machinery, this "Sil-Clad" motor is more reliable and more resistant to corrosion than conventional Class A or B totally enclosed, fan cooled motors of the same rating. And it cost $3000 less than a comparable TEFC motor built with ordinary insulating materials. Lower initial costs combined with greater reliability and lower maintenance costs account for the rapidly increasing market for such motors. *No. 208*

*T.M. REG. U.S. PAT. OFF.

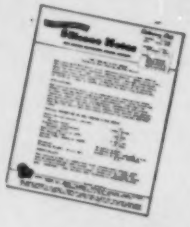
1955 CHEMICAL ENGINEERING AWARD WON BY DOW CORNING CORPORATION

New York — Dr. Sidney D. Kirkpatrick, editorial director of Chemical Engineering magazine has announced that the 1955 Award for Chemical Engineering Achievement will be presented to Dow Corning Corporation. The selection was made by an 84-man committee of senior chemical engineering educators headed by Professor Walter G. Whitman, director of the chemical engineering department, Massachusetts Institute of Technology. Dr. W. R. Collings, president of Dow Corning, will accept the award December 7 at a special presentation banquet to be given in Philadelphia during the 25th Biennial Exposition of the Chemical Industries.

Silicone News

DOW CORNING CORPORATION

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Silastic R Tape provides a convenient method of forming a resilient, moisture-proof, electrical insulating jacket that remains serviceable at high temperatures. Available in various widths and thicknesses this silicone rubber tape is excellent for wrapping Class H field and armature coils, transformer and solenoid coils. *No. 212*

Specifications for Silicone Fluid-Electrical Grade is a new data sheet that briefly describes the various tests of dielectric and physical properties that electrical grade Dow Corning 200 Fluid must pass before shipment. *No. 213*

Silicone mold lubricants serve the rubber industry by cutting mold maintenance costs as much as 80%; reducing rejects; improving surface finish and detail of rubber parts. Booklet describes properties, performance and application of all types of Dow Corning silicone mold lubricants. *No. 214*

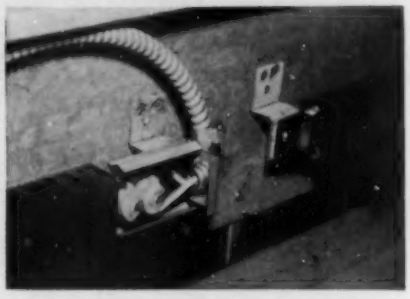
Silastic, the Dow Corning silicone rubber, keeps its shape, stays resilient from —100 to 500 F; resists hot oils and chemicals; withstands weathering ozone and corona; and is an ideal dielectric material. Properties of Silastic are fully detailed in new reference brochure. *No. 215*

Silicone Foaming Powders produce heat-stable, noninflammable, easily machined, low density foam structures for electrical and thermal insulation. Supplied ready to use, they can be foamed in place and often cured in service. Data sheet suggests applications; describes properties and foaming characteristics. *No. 216*

Documentary film "What's a Silicone?" available free of charge for showings to technical audiences in every industry. In full color and sound, this dramatic 16mm film allows you to see Dow Corning Silicones in action improving the performance of products ranging from nursing bottle nipples to diesel locomotives. For more information about this educational film and how to arrange a showing for interested persons in your plant, circle *No. 217*

FAST RELIABLE DEFROSTING WITH SILASTIC INSULATED LEAD WIRE

Take temperatures low enough to preserve frozen foods in an open display case and high enough to defrost the case in a hurry, and you have an ideal climate for Silastic*. Serviceable at temperatures ranging from —100 to 500 F, Silastic insulated lead wire solved the problem of a fast and reliable defrosting system for Tyler Refrigeration Corporation.



Originator and leading producer of open frozen food display cases, Tyler employs high-powered strip heaters for fast, automatic defrosting. Twice daily, temperatures at the terminal connections may jump from a low of —30 F to a high of 212 F and remain there for 30 to 50 minutes at a time. At such temperatures, the organic rubber insulation on conventional lead wire deteriorates rapidly. Unexpected failure could mean the loss of hundreds of dollars worth of frozen foods.

Tyler eliminated the possibility of insulation failure due to high temperatures, and gained Underwriters' approval at the same time, by specifying lead wire insulated with Silastic. In the thousands of frozen food cases that have been put into service since 1951, no lead wire failures have ever been reported.

For extra protection against moisture condensation, Tyler coats the connection between the terminal strip and the bare wire with Dow Corning 4, a non-melting waterproof silicone dielectric compound. *No. 209*

*T.M. REG. U.S. PAT. OFF.

SILICONE HYDRAULIC FLUID *(continued)*

limited because the organic oil became so thick at low temperatures that it could not pass freely through the port and valves. Even at 20 F the viscosity of this oil increased to 2400 Saybolt seconds.

Faced with the problem of "winterizing" the standard Hypress for operation at temperatures down to —30 F, Burndy engineers developed a special packing only to find that low temperature organic oils caused excessive swelling. Then they tried a 20 centistoke Dow Corning 200 Fluid with a viscosity of only 420 Saybolt seconds at —30 F and 68 seconds at 130 F.

The silicone fluid filled unit operates just as easily at —30 F as organic oil-filled units do at room temperatures. Swelling of the packing is eliminated. Utilities now use the Hypress in all seasons with equal ease. Field checks made since 1950 show that the investment made in Dow Corning 200 Fluid has been repaid many times over in additional sales resulting from dependable year around service. *No. 210*

SILICONE ADHESIVE *(continued)*

operate their tank plant overtime to meet production demands. One of the most time consuming jobs in the plant was hand welding a combustion-chamber skirt to the base of each heater to comply with American Gas Association requirements for the prevention of flue gas escape.

In 1954, at the suggestion of Mystik Adhesive Products Co., White production men tried sealing this 48-inch seam with a new Mystik tape coated with Dow Corning Adhesive. The seal passed all AGA tests, including constant high fire and surface temperatures in the range of 520 F. With this new tape, White realized material savings amounting to 7c a unit. Production in the tank plant has doubled. *No. 211*

Dow Corning Corporation, Dept. 8611, Midland, Michigan

Please send me: 208 209 210 211 212 213 214 215 216 217

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING CORPORATION
MIDLAND MICHIGAN

first in silicones

DOW CORNING SILICONES

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

we "threw away the book" to make this die casting...

● Thin walls blending into heavy sections made this a tough one . . .
but **Stewart** turns out castings like this in volume

After 45 years, Stewart Die Casting is still young enough to have new ideas. When conventional methods are not good enough, we "throw away the book" and find a way. Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications ...on time.

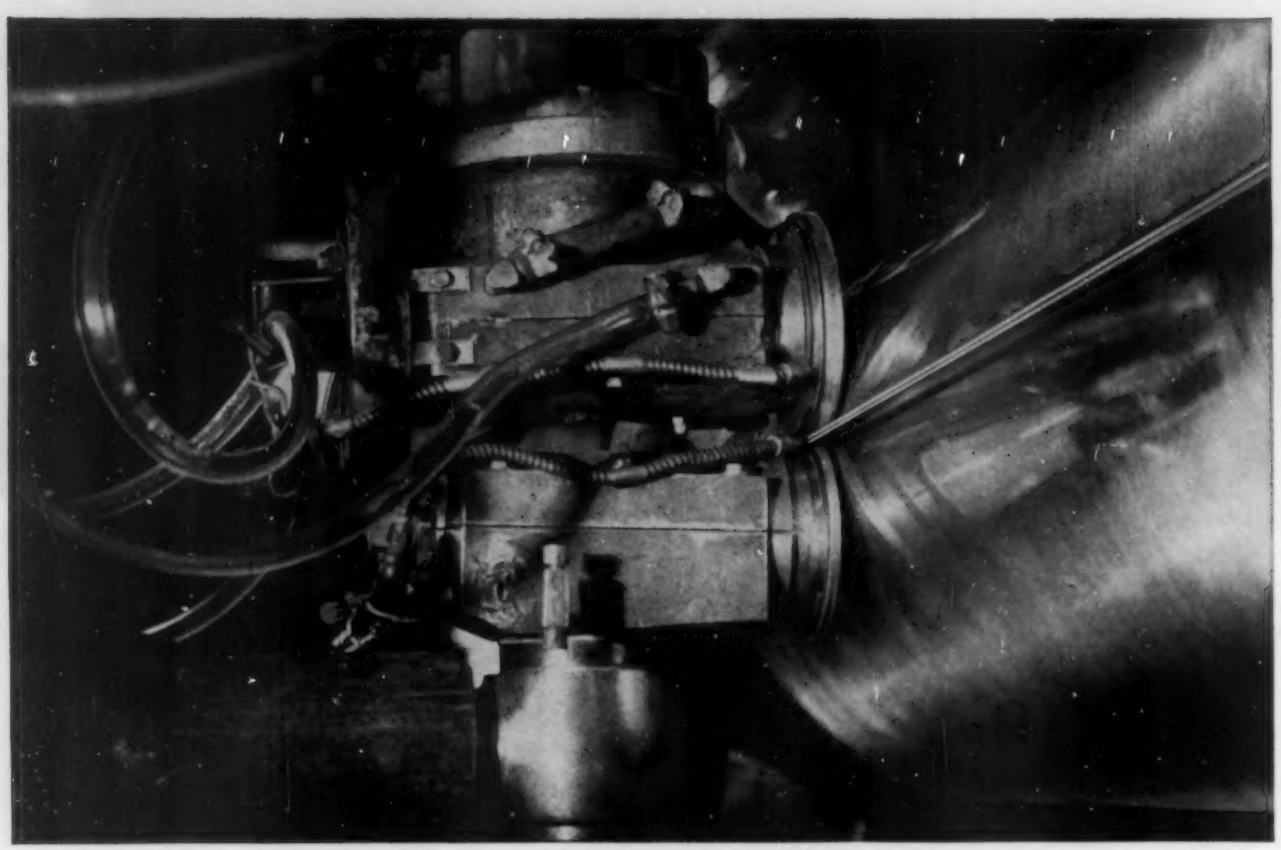
SERVICES AVAILABLE . . . **Designing • Engineering • Die Making Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.**

45 years of helping industry to "Make It Better"

Stewart DIE CASTING

...a division of STEWART SW WARNER

CHICAGO, ILLINOIS, 4535 FULLERTON AVENUE • BRIDGEPORT, CONNECTICUT, 275 WARREN STREET



Skyline's Production Line methods such as this seam welding operation have reduced prices of Monel nickel-copper alloy tanks to a point within reach of most boat owners. This and other Inco Nickel alloys provide superior fabrication and mechanical properties. That's why Inco alloys are widely used in Skyline products.

Bill Jung doubles company's size and business...

MONEL helps young engineer break cost barrier

A year ago, BILL JUNG, a successful engineer, headed a small company that fabricated air-borne equipment exclusively.

Today, his company . . . SKYLINE PRODUCTS, INC., Deer Park, Long Island, New York . . . is twice as big. All because Bill Jung had a bright design idea that was made practical by Monel* nickel-copper alloy.

Watching his Sciaki spot and seam welders speed the output of aircraft weldments, Bill reasoned: why not use this method to weld fuel and water tanks for boats . . . resistance welding would cut the cost.

He checked with boat builders. He found not only definite interest, but also universal preference for Monel alloy because of its strength and corrosion resistance.

$40 cut from cost

However, not everybody could afford this alloy. Bill learned that hundreds of tanks were made of materials like steel or copper, coated with zinc, tin or lead to cut costs. But unlike Monel nickel-copper alloy, these materials do not respond to resistance welding.

Bill set up to make tanks by resistance welding. And typical of the result, Skyline now sells a welded Monel fuel tank for $85. The same size tank used to cost $125.

Along with fuel and water tanks, Skyline now produces hardware for boats, and other equipment made of Monel alloy. Because this alloy is tough, long-lasting, and corrosion-resisting all the way through, it withstands heat and cold as well as many acids, alkalies and salts. It's a material for use where you want strength and corrosion resistance . . . as well as low-cost production.

*Reg. Trademark

Whenever you are faced with a problem of finding an alloy to suit your needs, it will pay you to investigate Inco Nickel Alloys. A brief description of their properties and uses is contained in "Standard Alloys for Special Problems." A copy is yours for the asking . . . Write for it now.

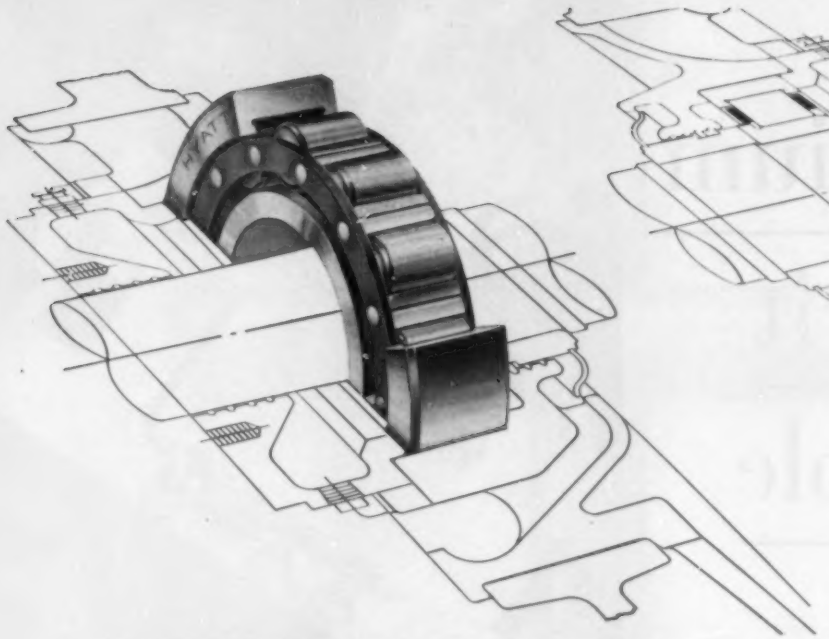
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

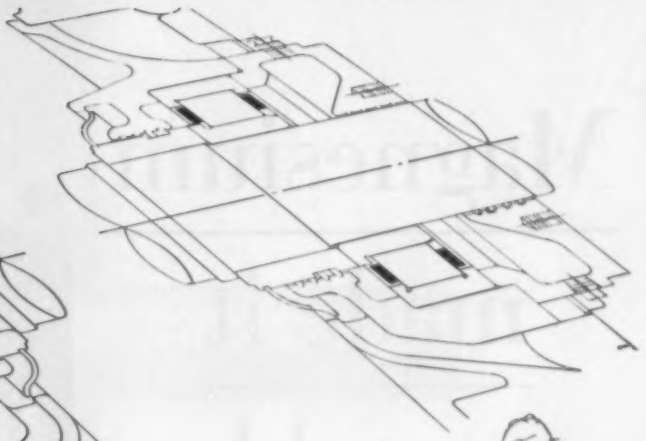
INCO
TRADE MARK

50 YEARS OF *Nickel Alloy Progress* PIONEERED BY MONEL
1905 - 1955

How Hy-Loads can help you . . .

OVERCOME OVERLOADING





HY POTENUSE, the sage of the slide rule, says:

This HYATT Hy-Load is heading for a long hard life. It's been designed into as tough a job as you can hand any bearing—the armature shaft of a steel mill motor.

These HYATT Bearings must maintain the armature on centers with very close running clearance despite the fact that *steel mill motors are frequently overloaded and are regularly reversed under full load!*

But ability to "take it" isn't the only reason leading motor builders mount HYATTS on both ends of armature shafts: the offset of the flanged inner race provides vital *inbuilt, non-adjustable free end float*, permitting the armature to center itself electrically. What's more, HYATT'S *separable and interchangeable* races facilitate quick replacement of armatures.

See why so many smart designers agree? *You can't go awry when you specify—*

YOUR COMPLETE LINE
OF CYLINDRICAL ROLLER BEARINGS

HYATT

ROLLER BEARINGS

STRAIGHT BARREL TAPER

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

DOW

Magnesium made it portable

Lightweight TOOLING PLATE builds advantages into portable fixtures . . . with important savings

THE DOW CHEMICAL COMPANY
Magnesium Sales Dept. MA 320B, Midland, Michigan

Please send the booklets checked below:

- ☐ Tooling plate brochure
- ☐ Booklet "Machining Magnesium"
- ☐ Booklet "Joining Magnesium"

Name_____

Title_____

Company_____

Address_____

City_____ State_____

There's a growing preference for magnesium tooling plate—and good reason, too! It's lighter in weight, easier to machine, and lower priced than most commonly used tooling materials.

The light weight of magnesium—⅔ the weight of aluminum, ¼ the weight of steel—permits ease of handling in portable jigs and fixtures for increased speed, safety and economy. Many other tooling uses benefit from magnesium's desirable properties.

Magnesium plate in all sizes is rolled for greater accuracy. Dimensional stability, too, is assured by stress relief through oven flattening.

Get all the details from your Dow Magnesium distributor, or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. MA 320B.

DISTRIBUTORS: COPPER AND BRASS SALES, INC., Detroit, Michigan • FULLERTON STEEL AND WIRE COMPANY, Chicago, Ill. • HUBBELL METALS INC., St. Louis, Mo. • A. R. PURDY CO., INC., Lyndhurst, N. J. • RELIANCE STEEL COMPANY, Los Angeles, Calif.

you can depend on DOW MAGNESIUM DOW

The Big Plus in Tubing

Remember
GM STEEL TUBING
By Rochester Products

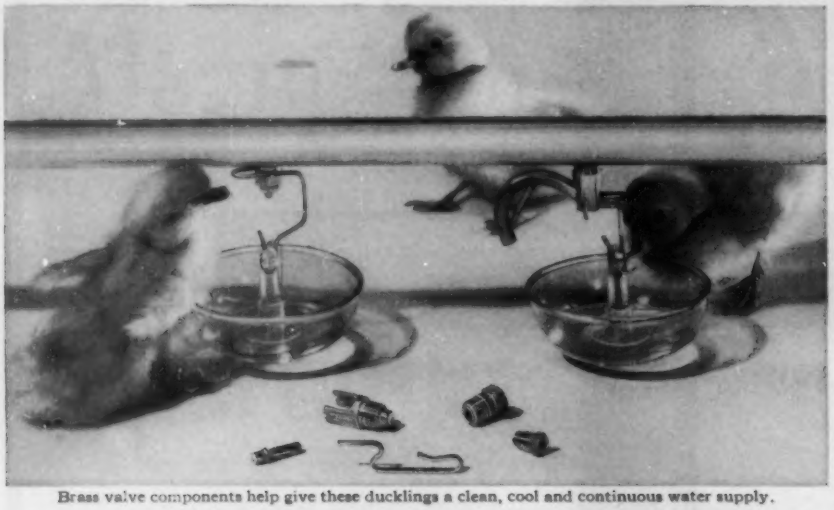
GM STEEL TUBING BY ROCHESTER PRODUCTS, DIVISION OF GENERAL MOTORS, ROCHESTER, N.Y.

BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co.

Reporting new developments in copper-base alloys and metalworking methods.



Brass valve components help give these ducklings a clean, cool and continuous water supply.

Automatic Drinking Fountains for Poultry Use Brass for Dependable Service

A good supply of clean, cool water helps to produce steady chick growth and good eggs, but the problem is to water poultry adequately without spillage, flooding, and, in the case of chicks, drowning.

A solution to this problem is the ingenious automatic drinking fountains made by Drinxall Manufacturing Company of North Hollywood, California.

With parts fabricated from Bridgeport copper-base alloys to Drinxall's own design, these poultry fountains are self-filling and sanitary. Poultry can't get in, nor water out, and chicks do their drinking right in pens, batteries or cages.

Drinking cups are suspended from water-supply lines by valves made from Bridgeport Free-Cutting Brass Rod Alloy 6 and by wire clips of Bridgeport Spring Brass Alloy 37. When water gets low in the plastic cups, a counterweight opens a supply valve until water reaches the proper drinking level, when the counterweight causes the valve to close.

Drinxall also uses Bridgeport copper-base alloys for a fountain using a peck-type valve, the valve opening when poultry peck at the moist valve stem.

The small, yet accurately made parts for the Drinxall valves shown are made from Bridgeport Free-Cutting Brass Rod Alloy 6. A composition of 61% copper and 3.4% lead gives this alloy exceptionally free-machining properties and a uniform composition. The use of Bridgeport Alloy 6 also assures accurate dimensions, essential in close-tolerance parts such as the small Drinxall valves shown above. Bridgeport Free-Cutting Rod Alloy 6 gives manufacturers a fast-production alloy ideal for high-speed, economical machining. Its strength and uniform composition serve close-tolerance requirements and make it particularly suitable for valves. Precision finishing assures efficient functioning, including perfect closing of metal-to-metal valve seats.

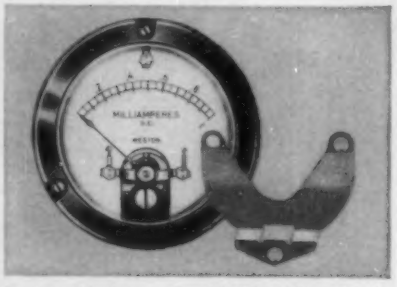
Bridgeport Copper Alloys were selected for Drinxall fountains because of their uniform high inner quality and consistent conformity with specifications covering composition, temper, finish and dimensions.

In thousands of cases such as this one, Bridgeport Technical Service representatives studied the requirements of an application, then recommended materials that have given satisfaction to manufacturers and customers alike.

Bridgeport Technical Service will recommend the alloys best suited to your particular applications, manufacturing methods, and production requirements. Call your local Bridgeport office for this helpful advice.

Magnet Holders Stamped from BRIDGEPORT Nickel Silver Withstand Rugged Use, Meet High Standards

To insure that the ruggedized meters it manufactures are able to withstand hard use, Weston Electrical Instrument Corp., Newark, New Jersey, uses only the sturdiest of materials. In addition, these Weston instruments are tested on machines such as a 2,000 foot-pound shock-testing machine and various vibration-testing machines.



Weston Milli Ammeter Model 1521 uses the Nickel Silver Magnet Retainer inset at right.

A typical Weston part is the magnet retainer (shown above) stamped and formed from Bridgeport Nickel Silver Grade B 555. This alloy has high strength and corrosion resistance, plus good spring properties and high electrical resistance. These properties make Bridgeport Nickel Silver B 555 ideal for telephone boards, radio parts, electrical controls, optical goods, surgical and dental instruments, and diaphragms.

Weston's magnet holder is formed so that its base has a slight buckle which flattens when the holder is fastened to the instrument housing. Permanent spring action of Bridgeport Alloy B 555 secures the magnet holder.

In this application, as in others, the selection of suitable Bridgeport alloys was made after Bridgeport's technical service and laboratory experts studied the metalworking requirements of the manufacturer, then recommended the exact alloy, temper, finish and size—not only to meet specifications, but to assure product quality and sales acceptance.

Bridgeport's helpful services . . . and 90 years of metalworking experience . . . are available to you through the nearest Bridgeport sales representative.

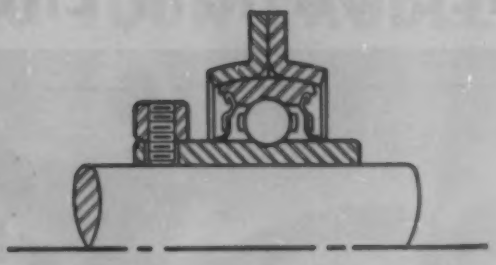
(3970)

Bridgeport Brass Co.

BRIDGEPORT BRASS
COMPANY ♦ BRIDGEPORT, CONNECTICUT

Mills at Bridgeport, Conn., Indianapolis, Ind., and Adrian, Mich.
Sales Offices in Principal Cities—Conveniently Located Warehouses

LOW COST is achieved with the use of an especially sturdy, pressed steel housing that combines strength and light weight, yet equipped with the same high quality precision bearing used in all Link-Belt ball bearing blocks.

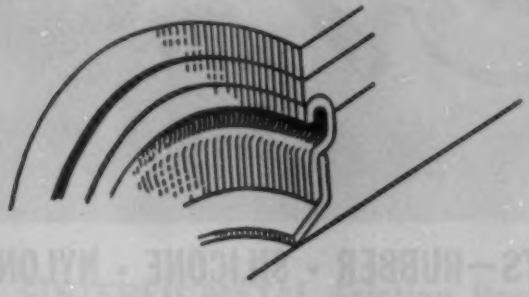


UNRESTRICTED SELF-ALIGNMENT. Aligning surface of housing is precision-coined to assure proper fit and support of bearing. Free-rolling action and full load capacity are maintained even with shaft misalignment.

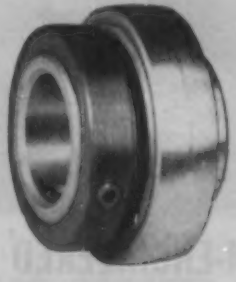
It's important

bearing differences

like these that add up to strength plus economy



MAXIMUM SEALING EFFICIENCY. Synthetic rubber lip-type seal, integral with the bearing, retains lubricant and excludes dirt . . . even in extremely dusty conditions. Greased at factory, bearing needs no further lubrication.



SINGLE-ROW, DEEP GROOVE BALL BEARING assures smooth operation and long life. Manufactured in accordance with the standards for the Anti-Friction Bearing Manufacturers Association BCO2 ball bearings.

They're all present only in this new, low-cost LINK-BELT ball bearing

HERE's the kind of specialization you get in industry's most complete line of ball and roller bearing blocks. The wide-spread need for a low-cost bearing—offering precision, anti-friction bearing performance—led to development of the JPS-200. Bulk is minimized—unrestricted alignment and effective sealing characteristic of Link-Belt bearings are maintained. The result is a bearing that costs you less . . . yet can challenge any for efficiency in light-duty applications.

Every Link-Belt bearing is made to meet just such a specific need. Ask your Link-Belt office for Folder 2517 on the JPS series. Get Book 2550 for data on Link-Belt's complete line.

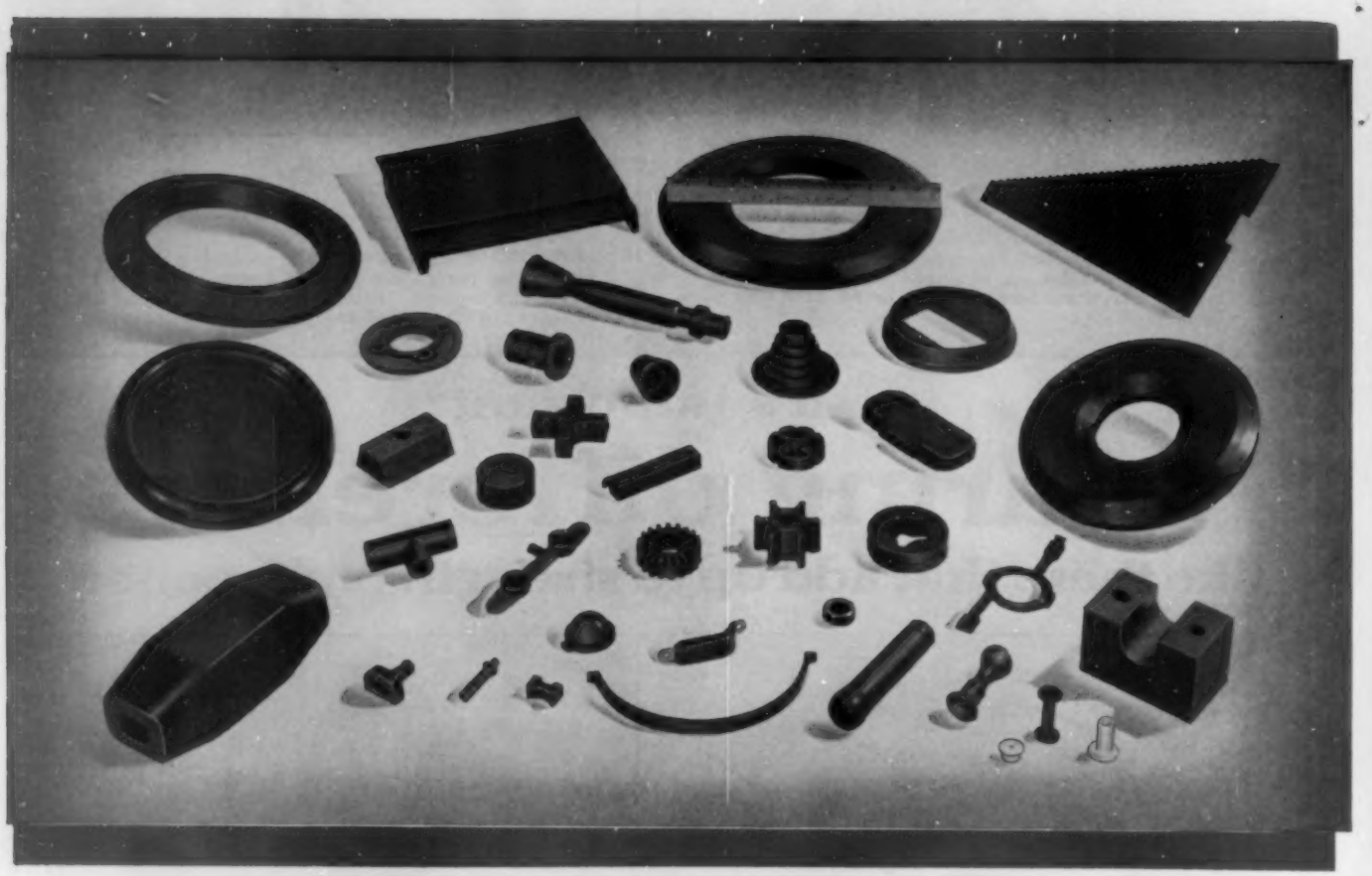
Low-cost series JPS-200 is part of industry's most complete line of ball and roller bearing blocks.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,713

CALL ON R/M ENGINEERING SERVICE



CUSTOM-ENGINEERED MOLDED PARTS—RUBBER • SILICONE • NYLON

R/M engineers can help you solve product problems with precision-made molded parts of natural or oil-proof synthetic rubber, silicone or nylon. R/M molded parts are custom-engineered to meet your particular requirements—to assure long life and trouble-free service under temperature, atmospheric, or other operating conditions. Specialists in the application of molded parts and components, R/M engineers assist you in determining the best design and material to meet new requirements . . . or to overcome troublesome conditions or higher costs caused by other materials you are now using.

Where your needs dictate, they will develop molded parts of natural or synthetic rubber. If silicone or nylon can do your job better, R/M will custom-engineer the exact parts you need to improve product performance, prolong product life or reduce cost. Backed by more than 60 years research and experience in the manufacture of molded and industrial rubber products, R/M molded parts are produced by skilled personnel working with the finest in laboratory testing facilities, under exacting quality control, and with modern mass-production methods. R/M offers you this same advanced engineering service with cut and extruded parts custom-made to your special order. Whatever your requirements, you can count on R/M for savings in design time and costs . . . and dependable deliveries.

A new, illustrated folder describes the unusual advantages of R/M Custom Molded Nylon Parts. Also, the R/M "Exclusive Features" book describes engineering advances in rubber hose, transmission and conveyor belts, V-Belts and R/M's new concept in power transmission, the Poly-V® Drive. Ask your R/M representative about Manhattan Rubber Division's Specialized Engineering Service for help with your rubber and nylon problems.

For booklet shown, or other data, write, phone or wire:

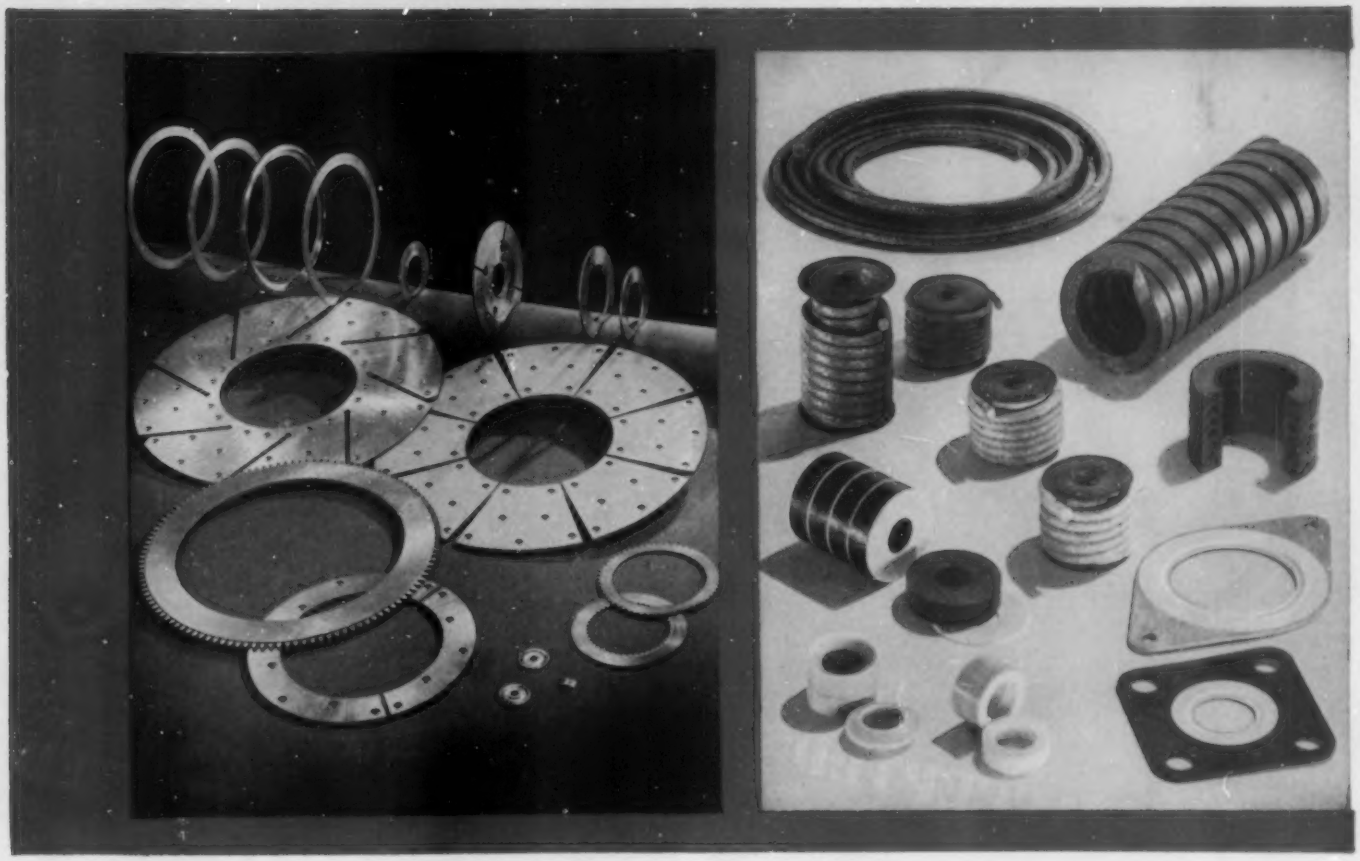
MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings | Fan Belts and Radiator Hose | Mechanical Packings and Gaskets | Abrasive and Diamond Wheels | Industrial Drive Belts | Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS



SINTERED METAL Friction Parts

Have a friction problem where high temperatures or close tolerances are factors? R/M Sintered Metal Friction Parts may be your answer. Under such severe conditions, R/M Sintered Metals will perform without appreciable increase in wear rate because of their high thermal conductivity and absence of destructible bond. Remember, unlike most manufacturers, R/M works with all kinds of friction materials. So whatever your friction requirements, you can be sure of completely unbiased advice when you consult Raybestos-Manhattan.

Write for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

PACKINGS, GASKETS, Asbestos Textiles and "TEFLON"* products

R/M makes packings and gaskets for every conceivable application. They are used wherever it is necessary to seal against air, gas, water, steam, oil, chemicals, solvents, food products, and hydraulic fluids. R/M also makes a wide range of "Teflon" products and a great variety of asbestos textiles. If you have a problem in design or manufacture that any of these products might solve, don't hesitate to call on R/M's specialized engineering service for advice.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

For booklet shown, or other data, write, phone or wire:

PACKING DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J. • Gregory 3-2000

ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa. • Manheim 5-2211

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Conveyor Belts

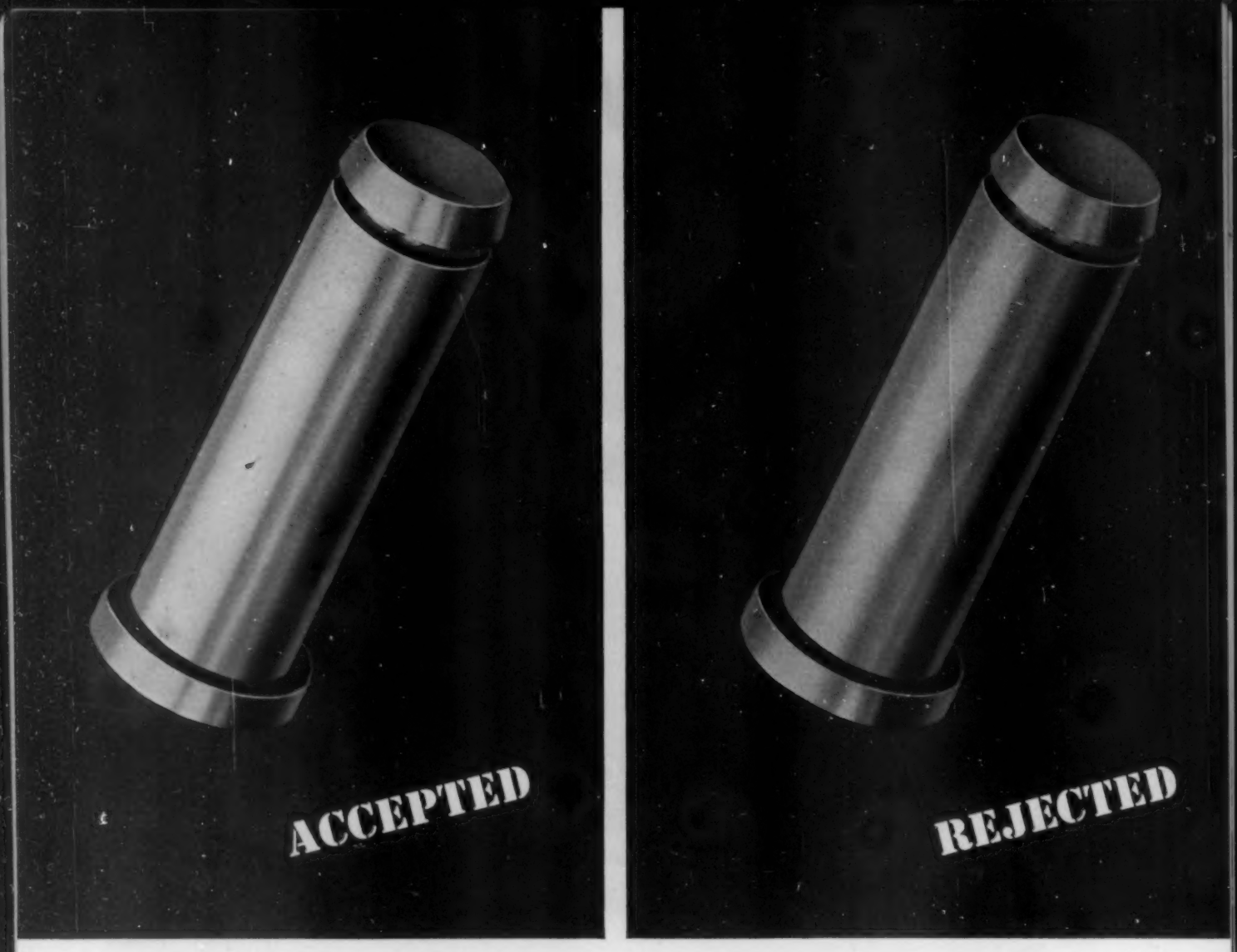
Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics



THE DIFFERENCE... *Carpenter* stainless uniformity

These hinge pivot pins for automatic dishwashers were being turned out by "doing things the hard way." Tools had to be reground every eight hours. The ordinary Type 303 steel used wasn't uniform, refused to hold size, and didn't provide the required finish.

This job could easily have been chalked up as a "necessary headache," but someone wasn't satisfied . . . was willing to explore the possibilities for improvement. As a result, Carpenter Stainless No. 8 (Type 303) has brought these worthwhile changes: Tool regrinding is required only every 18 to 24 hours . . . final grinding of the part is eliminated because size tolerances were held so accurately . . . bar after bar machines the same . . . and each part now costs 50% less.

Build your own improvement program with the cooperation of Carpenter . . . originator of the first Free-Machining Stainless. The steel can be in your plant almost immediately if you call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor now. *The Carpenter Steel Co., 117 W. Bern St., Reading, Pa.*

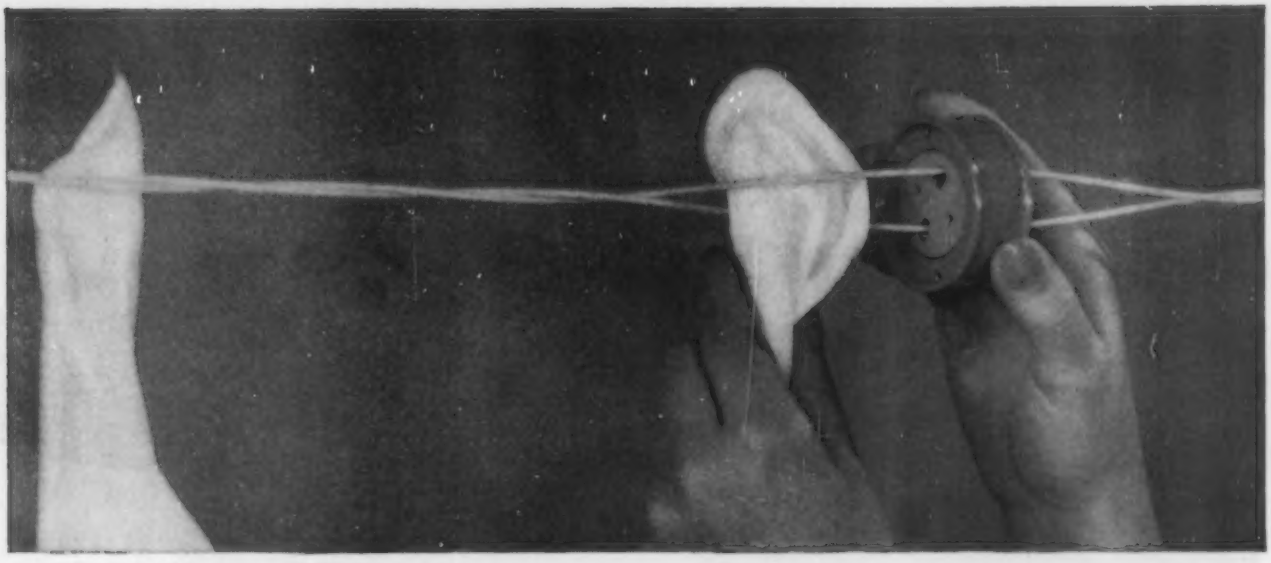
Specify Carpenter . . .
the one stainless job-proved to give you:

easier machining
fewer rejects
smoother finishes
lower production costs

Carpenter STEEL

Free-Machining Stainless Steels

IMMEDIATE DELIVERY from local warehouse stocks — Export Address: Port Washington, N. Y. — "CARSTEELCO"



New twist for washday!

— "Pin-O-Matic" Clothesline manufactured by **Dennan Mfg. Co.**, 1 Washington Ave., Providence, R. I.

BAKELITE Brand Elastomeric Vinyl plastic extruded on twisted twin strands of wire makes the new "Pin-O-Matic" clothesline gentle to both the wash and the housewife's hands. The line won't rust or flake. It is easily wiped clean, leaving the gleaming white surface smooth as new. No matter how often the strands are parted by the disk-shaped spreader, the jacket of BAKELITE Elastomeric Vinyl retains its resilience for a safe, secure grip.

This is only one example of how you can use BAKELITE Elastomeric Vinyl compounds in products that must resist water, heat, and cold. The flexibility of these compounds can be varied according to your needs, from semi-rigid to soft. Transparent, translucent, or opaque, these materials can be pigmented to a wide range of colors with a high-gloss or soft matte finish.

Learn how BAKELITE plastics and resins can help you market new products. Write Dept. LE-145.

BAKELITE
BRAND
Vinyl Resins

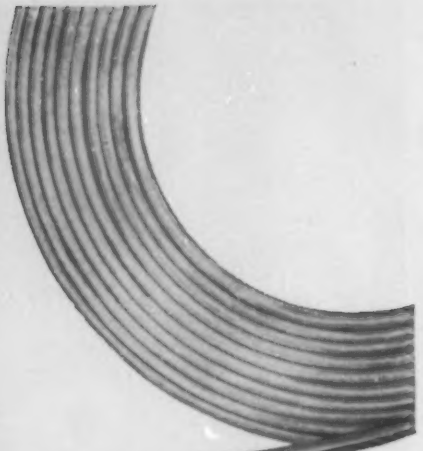
BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

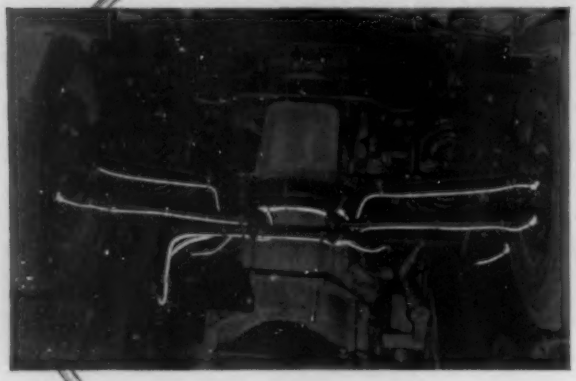
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Look what they're doing with

nylaflow*

...the great NEW ADVANCE in tubing by POLYMER

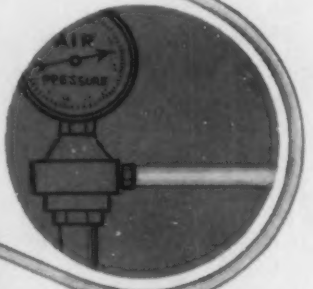


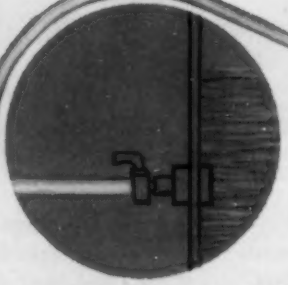


Just think of the many uses for a tubing with all of nylon's abrasion and corrosion resistance, flexibility, resiliency, and other desirable properties! What's more, NYLAFLOW* tubing usually cuts initial tubing and assembly costs. There's no pre-bending, only two connections are needed, and you can use either standard flare or compression fittings. NYLAFLOW tubing is supplied in stock diameters and lengths, and in two grades: Type T with a tested bursting strength of 1,000 psi and Type H, 2,500 psi. Just take a look at some of its exciting possibilities!

*NYLAFLOW** LUBRICANT LINES

In the new push-button power lubrication system for 1955 Lincoln and Mercury automobiles, Lincoln Engineering Co. of St. Louis chose NYLAFLOW tubing because it is dent proof and flexes as chassis members move. NYLAFLOW also costs less than other tubing tested, and is faster, cheaper, and easier to assemble and install.





*NYLAFLOW** AIR LINES

NYLAFLOW should give excellent results in air lines for pneumatic instruments and control valves, pneumatic equipment and tools, pumps and water systems, etc.

SEND FOR NEW *NYLAFLOW* TUBING BULLETIN

*NYLAFLOW** FUEL AND OIL LINES

NYLAFLOW tubing's properties indicate added abrasion and fatigue resistance, as well as lower cost, for fuel and oil lines on internal combustion engines, etc.

*NYLAFLOW** PROCESS LINES

NYLAFLOW is not subject to corrosion, nor is it attacked by most organic solvents, process gases or strong alkalies. This suggests it should be ideal for plant gas and fluid lines.

THE POLYMER CORPORATION
of Penna. • Reading, Penna.

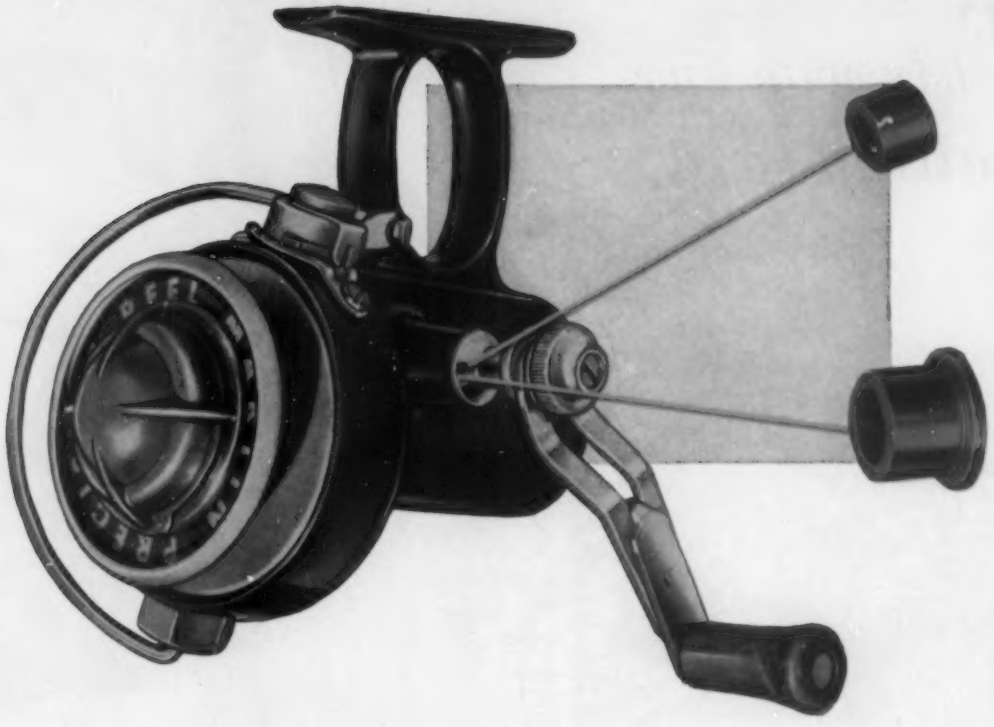
POLYMER *NYLAFLOW TUBING**
... nylon ... Teflon ... and other non-metallic shapes

In CANADA: Polypenco, Inc., 2052 St. Catherine W., Montreal, P.Q.

Teflon is the trademark for DuPont tetrafluoroethylene resin

*NYLAFLOW is the trademark for The Polymer Corporation's nylon tubing

ONLY CHRYSLER MAKES OILITE®



one-half million spins under tension and— OILITE bearings show no appreciable wear

Here's a fishing reel that is subjected to laboratory tests far more drastic than it receives from anglers —*and the self-lubricating OILITE bearings take it in stride.* Here's what the spinning reel manufacturer reports:

"Last summer we had one stock reel tested under tension (up to and including four pounds) at varying speeds. This reel had your bearings, of course.

"Our original intention was to give the reel a breakdown test. However, after running the reel under tension 186,727 revolutions of the crank handle, actually revolving the head over half a million times, we found that the bearings showed no appreciable wear. *In fact, your bearings appeared only slightly worn in. This is a terrific recommendation, in our opinion, for your bearings.*"

The impregnated oil in self-lubricating OILITE bearings is held in storage by capillary attraction and provides a surface film for positive, constant lubrication. OILITE bearings are particularly successful in trouble areas where it is difficult or impossible to provide lubrication. The built-in oil cushion absorbs heavy shocks and stresses.

Chrysler engineered OILITE bearings are made of various metals and alloys in a wide range of sizes for a multitude of uses. Standard bearings and bearing material (cored, bar and plate stock) are available from local dealers throughout the U.S. and Canada.

Contact Amplex for help with your bearing problems. The engineering facilities of Chrysler-Amplex are available to serve you. OILITE Field Engineers, Supply Depots and Dealers in all principal cities. Overseas distribution thru Chrysler Export.

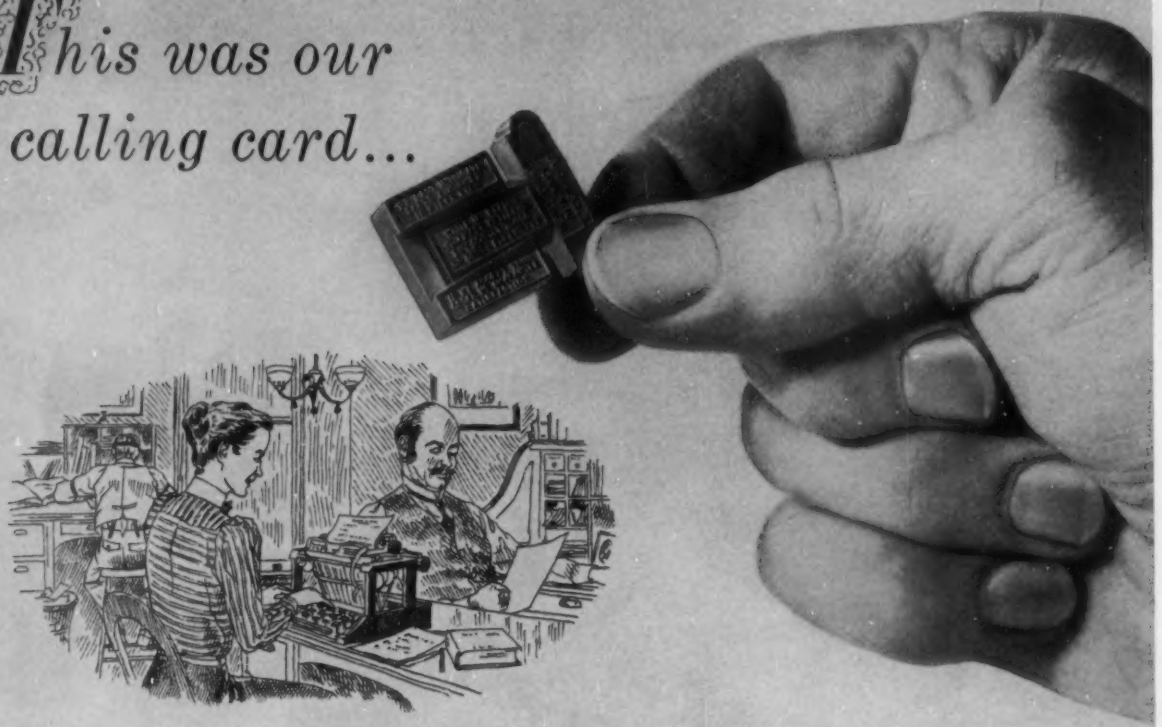
Chrysler-Amplex also manufactures Permanent Metal Filters, Finished Machine Parts and Friction Units.

OILITE . . . *In Powder Metallurgy . . . It's Amplex*

CHRYSLER CORPORATION
AMPLEX DIVISION
Dept. F-11, Detroit 31, Michigan

IT'S NEW! IT'S FREE!
First complete information on self-lubricating bearings, finished machine parts, filters and other powder metal units. 52 pages. Write today for OILITE Engineering Manual E-55.

This was our calling card...



50 YEARS AGO

Yes...exactly fifty years ago, the skillfully cast piece of zinc shown above in actual size was the ingenious calling card used by our founder, Carl J. Moberg, to tell potential customers about the new die casting business he had just started at Mount Vernon, N. Y.

The legend it carried was significant—and prophetic. On one side it reads:

Cast by C. J. Moberg, Inc. Reliable Die Casting. And on the reverse:

We cast intricate parts finished in steel dies.

Write us before you make patterns, buy costly tools, or order elsewhere.

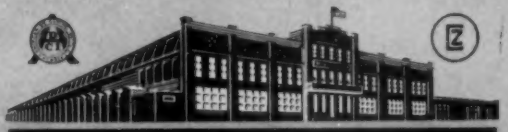
If we accept your order, we guarantee satisfaction.

It is superfluous to point out at length how greatly the world around us has changed since Carl Moberg handed out his "calling card." On country roads, horses were still prone to rear up in terror at the occasional automobile. Carl Moberg never die cast a part for even so "commonplace" a product as an electric iron. There were none.

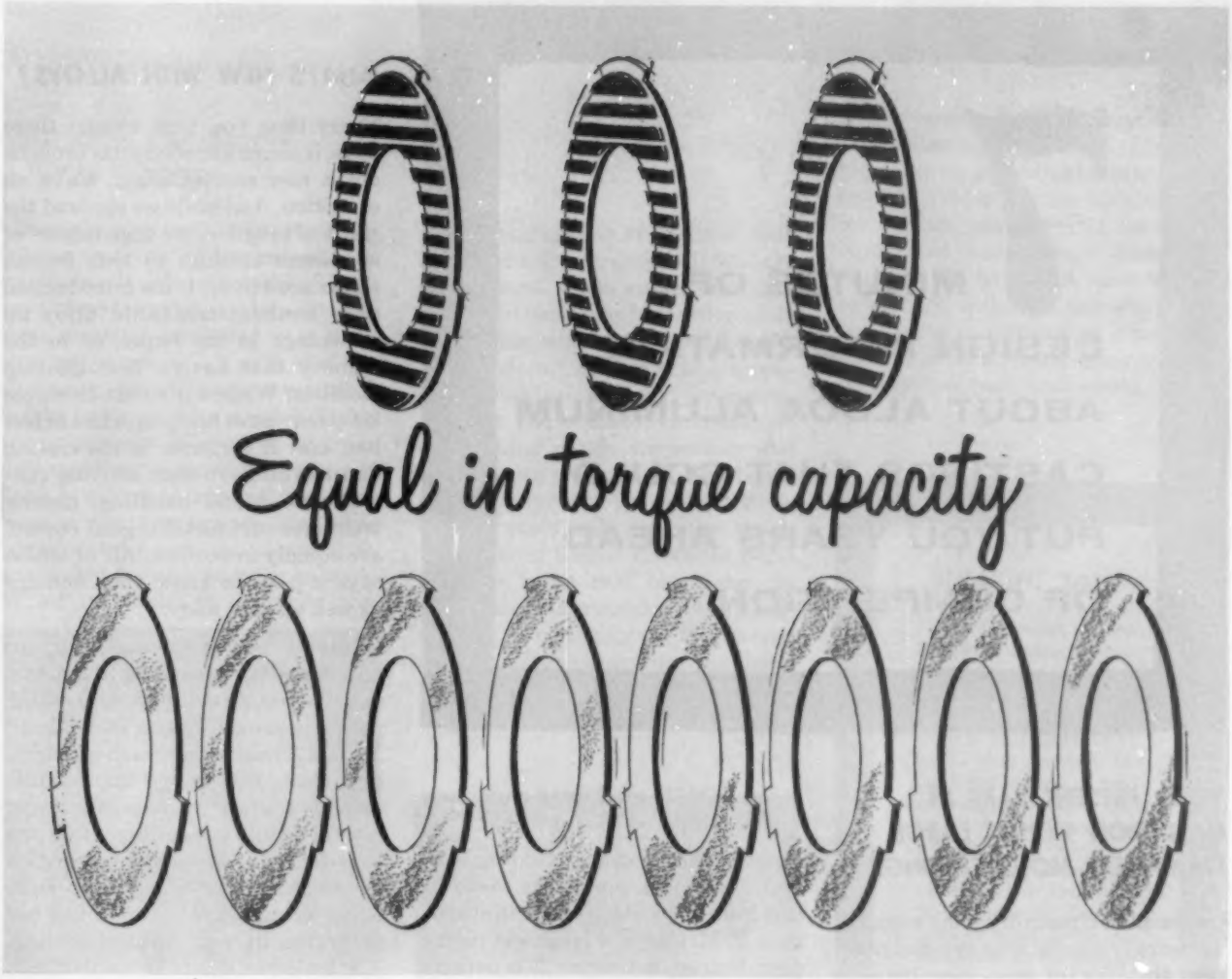
Nor could he foresee the enormously expanded physical facilities, in 1955, of the business he began—with our 165,000 sq. ft. of floor space, with our complete tool and die shop, our automatic electric furnaces, our forty die casting machines.

One basic thing, however, has *not* changed. It is the essential reason, we are sure, for Mount Vernon's growth. Carl Moberg indeed founded well.

"If we accept your order, we guarantee satisfaction."



MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



How to make 3 clutch plates do the work of 8

A leading appliance manufacturer modified the transmission in his automatic washing machine to make use of cork-faced clutch plates.

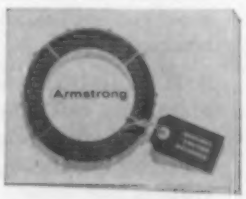
The result? A lighter, simpler, less costly transmission—with the required torque now being delivered by three cork facings in place of eight other plates called for by the original design.

Cork makes design economies like this possible because of its inherently high torque capacity. Cork, in fact, retains a higher coefficient of friction when immersed in the oil of a wet clutch than any other friction material. Because of this, cork will transmit a given amount of torque with fewer or smaller plates —or lower engagement pressures. This permits the use of smaller, less complex hydraulic systems.

Cork helps reduce costs in other ways, too. First of all, it costs less than most friction materials. And there's no need for surface or finish grinding when you use cork facings. They're resilient and mate perfectly with their opposing plates.

Most important, cork is a *dependable* facing material. A cork facing in a properly designed wet clutch will last the life of an appliance or automobile. There's virtually no wear in normal service—and no abrasive particles to contaminate oil and damage gears.

For the whole story on cork friction materials, send for a copy of "Armstrong Resilient Friction Materials." Write Armstrong Cork Company, Industrial Division, 7211 Irvin St., Lancaster, Pa.



Armstrong FRICTION MATERIALS

. . . used wherever performance counts

(*Advertisement*)

7 MINUTES OF DESIGN INFORMATION ABOUT ALCOA ALUMINUM CASTINGS THAT COULD PUT YOU YEARS AHEAD OF COMPETITION.

YOUR PRESENT PART IN CAST IRON VERSUS LARGE PERMANENT-MOLD CASTINGS

On the pure chance of saving a buck, we heartily suggest that any designer now thinking of cast iron turn a calculating eye in the direction of aluminum permanent-mold castings. Our reasoning goes like this:

1. Cast iron *must* be cast in fairly thick sections—often stronger than you need. This isn't true of aluminum, and the resulting weight saving often is larger than the accepted ratio of 2.6 to 1.

2. Big iron castings usually require large dry sand cores. This isn't cheap in a foundry. If quantities are reasonable, the cost of an aluminum permanent-mold casting becomes extremely competitive.

3. The lighter weight of an aluminum casting over its iron counterpart lowers shipping costs, eases handling during machining and speeds installation.

4. Aluminum's natural advantages over iron—notably resistance to corrosion—can materially reduce maintenance costs.

5. Faster feeds and speeds possible in machining aluminum as compared to cast iron.

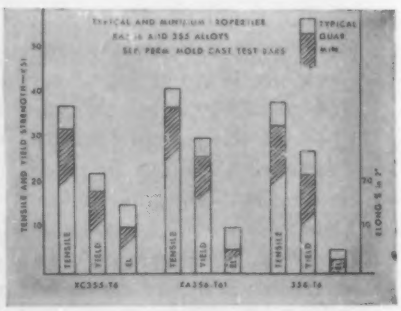
Proof of the foregoing pudding is in two recent jobs previously made in cast iron—now doing better in aluminum P. M. One is a large gas meter case. In iron, it weighed 500 pounds assembled. In aluminum, 175 pounds. Pressure tests prove it's stronger, and corrosion tests indicate practically no maintenance. Further savings are realized by easier handling and installation. The other job is bases for street lighting poles. Here the saving in maintenance is considerable, too. In both instances, use of Alcoa's research and development facilities clinched the economic argument in favor of aluminum. We can do that kind of thing for you, too.

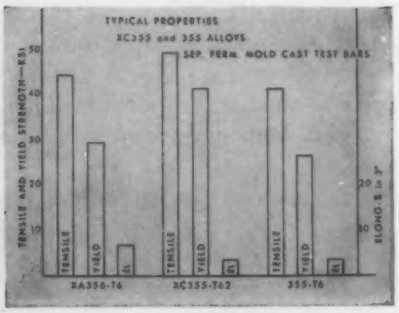
In iron it weighed 500 pounds . . .

WHAT'S NEW WITH ALLOYS?

Every time you turn around these days, it seems somebody has brought out a new casting alloy. We're no exception. And while we applaud the spirit of progress, we urge buyers of aluminum castings to look behind the scenes a little. Is the introduction of a nonheat-treatable alloy an advantage to the buyer, or to the foundry that has no heat-treating facilities? While a nonheat-treatable alloy may have fine properties in test bar, how it performs in the casting depends on more than alloying constituents. Metal handling, casting technique and metallurgical control are equally important. All of which says it pays to know your foundry as well as your alloy.

Having thus cautioned you, we now blow our own horn about two new Alcoa-developed alloys for permanent-mold casting: XC355 and XA356. These are new high-strength, high-elongation alloys that require careful control of impurities and careful foundry handling. Both are heat-treatable. Both can be handled in Alcoa foundries that are fully equipped to deliver close to test bar properties in your finished casting. The little bar charts below compare tensile, yield and elongation with the familiar 355 and 356. Structural assemblies and parts subject to impact seem most likely candidates for these new alloys. Any ideas?

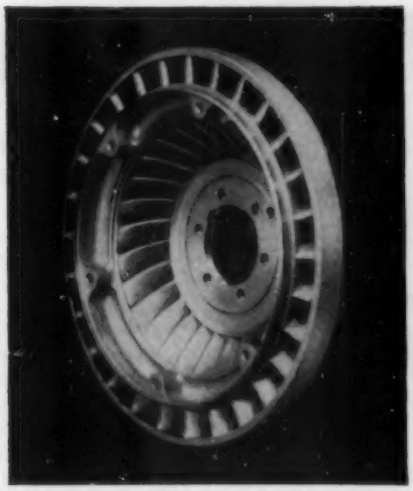




"PRECISION CASTINGS"? ± ½" or ± 0.005"

Close tolerance casting has its justification in terms of the subsequent machining it can eliminate. These days, close tolerance is a loosely used term meaning somewhat less than plus or minus ½". You'll find no shortage of foundries who are willing to take on a close tolerance job. There are proponents of everything from shell molding to investment casting. Each is willing to argue the advantages of whatever process they have equipment to produce. Since it is impossible for any foundry to work by all methods, it becomes the supplier's difficult choice to pick one or two. This Alcoa did several years ago.

Cast with thin steel inserts . . .



Not a speck of finish machining . . .

Precision casting at Alcoa is done in plaster and tolerances of 0.005" are not unusual. Parts we are currently making in plaster include automobile tire molds with thin steel inserts, called "sipes," to give tires a squeegee action on slippery pavement. Also for the automotive trade, we are making molds for rubber and plastic arm rests and dashboard covers. These have the characteristic leather grain cast into the mold. Thin-bladed torque converter parts are also being cast in plaster. In every case, not a speck of finish machining is necessary on the as-cast surface. The experience we have gained in such production is readily available to you.

A very profitable sandwich . . .

JOINING ALUMINUM CASTINGS —SANDWICH BRAZING

We're seeing more and more complex castings being broken down into a series of simple castings and then joined back together.

The machine tool valve body, shown above, is a case in point. As you can see, it has a series of intricate passageways to control hydraulic fluid. This part replaces many lines and fittings. It is practical only because it can be made inexpensively.

In this case, the center section is a sand casting of C612 alloy. The cover pieces are then brazed to the center casting by a furnace operation. Other applications of this technique are oil-cooled pistons for diesel engines, fuel regulator housings for jet engines, wave guides for radar equipment and cylinder heads for engines. We have had considerable experience with this sandwich-type construction, and are in a position to offer some interesting suggestions on any cast part that would apply.

STRAIGHT TALK

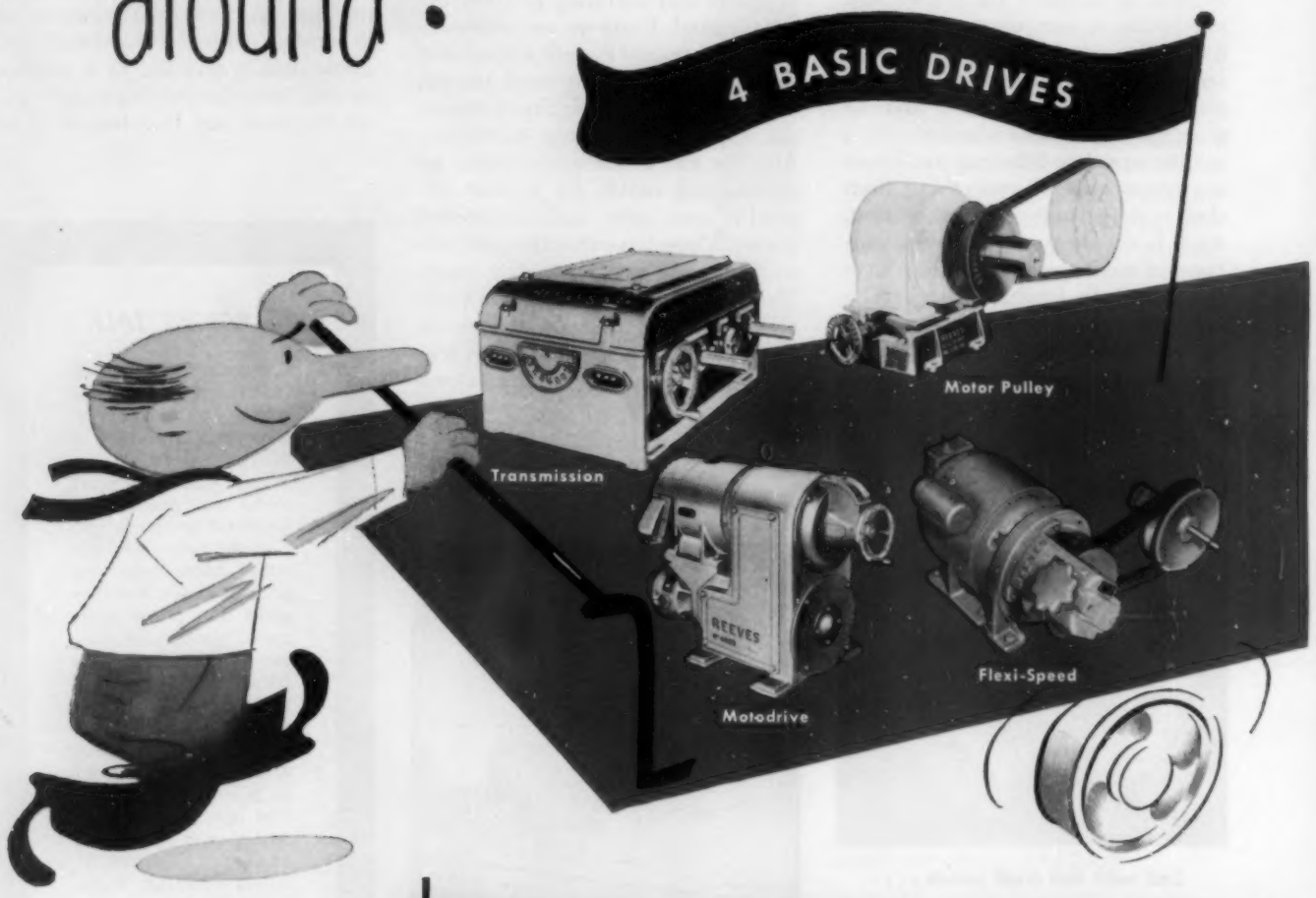
It is a fact that a hard look at aluminum castings has put a competitive edge on many a designer's thinking. When you take that look, you needn't be confined by one or two casting processes because Alcoa foundries produce all kinds—sand, die, permanent-mold, plaster and combination mold. To contribute solid technical thinking, at the design stage, your local Alcoa sales engineer is listed under "Aluminum" in your phone book. Use him. Or write to Aluminum Company of America, 1992-K Alcoa Building, Pittsburgh 19, Pa.

Your Guide to Aluminum Value

ALCOA ALUMINUM

ALWAYS FASTEN ALUMINUM WITH ALCOA® ALUMINUM FASTENERS

Why shop around? REEVES



REEVES

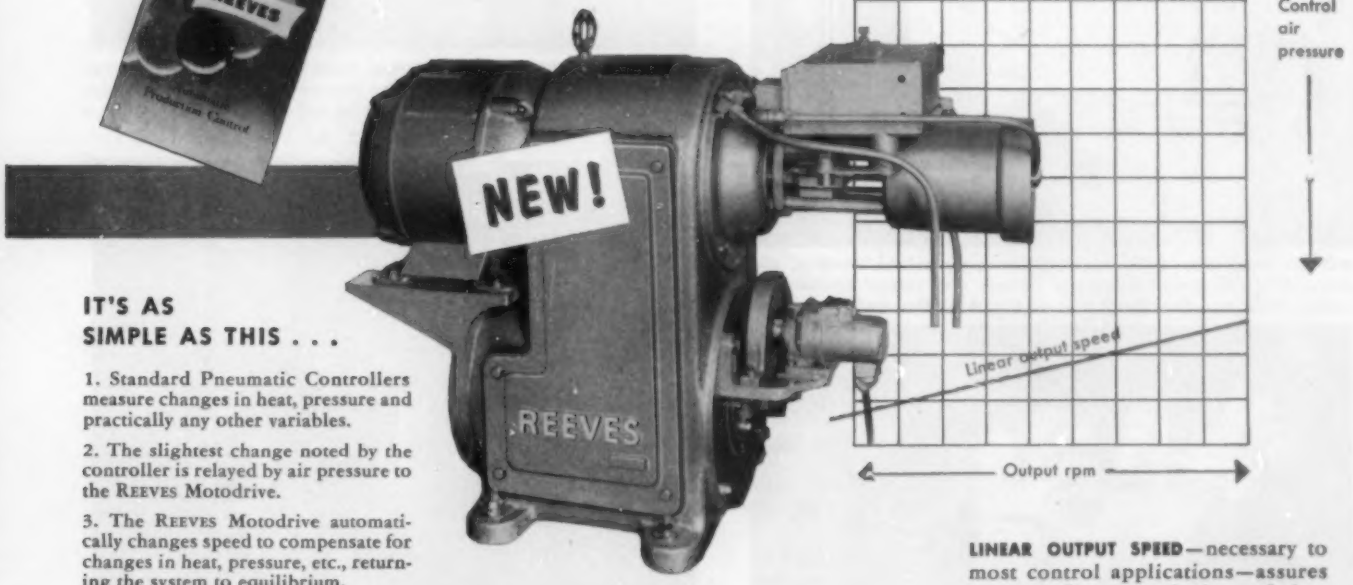
Recognized Leader in the specialized field of variable speed control

REEVES FLEXI-SPEED . . . *with new low speeds!*

Amazing *new* Flexi-Speed is but one outstanding example of the complete line of REEVES Variable Speed Drives. Now available with output speeds from 300 rpm to 4800 rpm—speed ratios as great as 8:1. Combines efficiency, versatility and *low price.*

offers the only complete line of variable speed drives and automatic controls

FREE! REEVES *New* Automatic Production Control Booklet — Specify K4a-G537



IT'S AS SIMPLE AS THIS . . .

1. Standard Pneumatic Controllers measure changes in heat, pressure and practically any other variables.
2. The slightest change noted by the controller is relayed by air pressure to the REEVES Motodrive.
3. The REEVES Motodrive automatically changes speed to compensate for changes in heat, pressure, etc., returning the system to equilibrium.

LINEAR OUTPUT SPEED—necessary to most control applications—assures exactness for proportioning and gives precise speed control *throughout the entire range* of the Motodrive.

REEVES AUTO-PNEUMATIC CONTROL

for regulating flow, pressure, heat, etc.

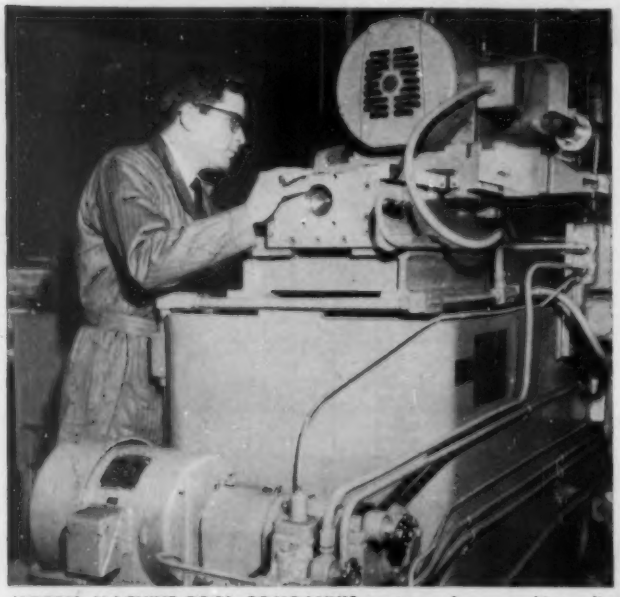
REEVES PULLEY COMPANY • COLUMBUS, INDIANA

Division of **RELIANCE ELECTRIC AND ENGINEERING CO.**

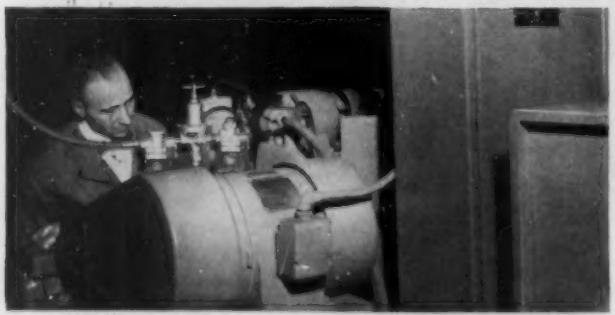
Designer's

New machines with TRI-CLAD motors highlight "motor switchover" at Machine Tool Show

The giant Machine Tool Show at Chicago demonstrated the tremendous effect made by the electric motor re-rating program announced in 1953. Over 62% of the G-E motors between 1 and 30 horsepower installed on machines at the show are built to the new dimensions. One reason for this big "motor switchover" by designers of machine tools is the new and better Tri-Clad '55', G.E.'s completely redesigned line of more powerful, more compact motors. Weight is reduced up to 33% in some ratings, size cut up to 40%. Installed on the newest machine tools, Tri-Clad motors give a neat, compact, modern appearance. Available in a wide range of ratings and enclosures, they're easily installed and maintained, and shipping and handling costs of your product are reduced. Check Bulletin GEA-6200.

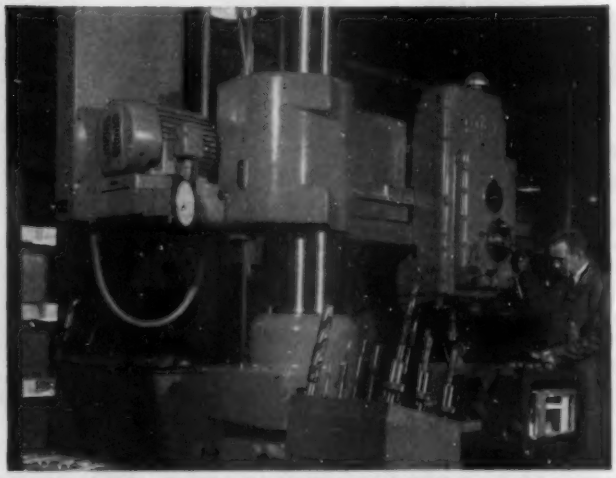


MORRIS MACHINE TOOL COMPANY'S center column machine, displayed at the Machine Tool Show in Chicago, uses several Tri-Clad '55' motors. Note attractive appearance of motors on this modern machine.



VAN NORMAN COMPANY exhibited Tri-Clad '55' motors driving wheel heads on several grinders. Also exhibited: totally-enclosed Tri-Clad '55' motors for feed and spindle drives on milling machines.

GOSS & DELEEUW exhibited multiple spindle tool rotating chucking machines. Tri-Clad '55' totally-enclosed fan-cooled motors in the 1–15-hp range are used for the tapping, drilling and feed drives.



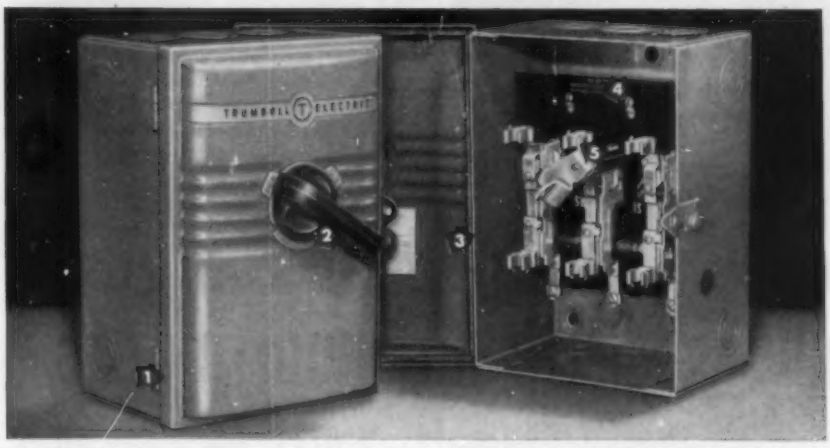
AMERICAN TOOL WORKS COMPANY uses Tri-Clad '55' totally-enclosed fan-cooled motor on its 32 speed Hole Wizard radial drill. TEFC construction assures smooth performance despite adverse atmospheres.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS

Tests prove G-E heavy-duty HCI switch provides extra safety margin of 66%



Normal tests call for a switch to operate at 6 times the motor full-load current. General Electric's 30-amp heavy-duty HCI switches operate successfully at 10 times full-load current, an extra safety margin of 66%. In addition, pole units can be individually replaced, reducing maintenance costs, and straight-in wiring makes installation simple. Quick-make, quick-break action helps prevent burning: operator can't "tease" contacts in or out. Sturdily constructed, these switches withstand severe electrical and mechanical stresses in a wide range of machine-tool control uses. Available in 30 to 200 amps, 125 to 600 VAC and 240 VDC in two- or three-pole construction.

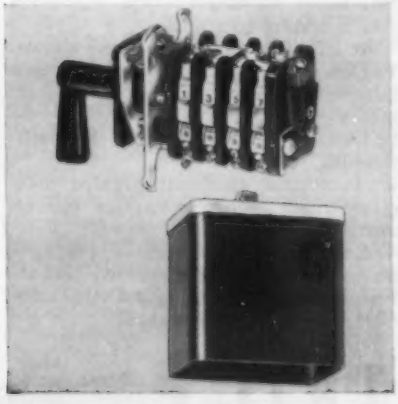
Note these features above: 1. Rigid piano-hinges on heavy steel door withstand abuse. 2. Easy-grip, unbreakable, front-operated handle. 3. Standard rubber gasket makes box semidust-tight. 4. Line shield guards against accidental contact. 5. Door interlocked. When handle is padlocked, door cannot be opened.

Specify G-E circuit breakers for fast action, durability

General Electric molded-case circuit breakers must meet 16 tests for quality, and are U/L listed. De-ionizing arc-quencher keeps operation cool and lengthens life. Both thermal and magnetic trip give safer positive protection, and fast indication of "off," "on," or "tripped," means production is not delayed. Solderless lugs and straight-in wiring make installation speedy, easy. Units are available with all standard accessories for industrial uses, and with enclosures for every purpose, including lead-plated water- and dust-tight enclosures for corrosive atmospheres. Separate stocking of breakers and enclosures speeds delivery. Bulletin GEC-1031.

Highly-versatile control switch: 50,000 circuit combinations

General Electric's SB-1 control switch has been used for as many as 50,000 different circuit combinations—from a meter to a complicated locking mechanism for a giant bridge. Continuous rating is 600 volts, 20 amperes. Interrupting rating depends on circuit voltage. Single switches having 16 stages (32 contacts) are commonly furnished. GEA-4746A gives complete details.



General Electric Co., Apparatus Sales Division, Sec. A668-126, Schenectady, N. Y.
Please send me the following bulletins:

√ for reference × for immediate project

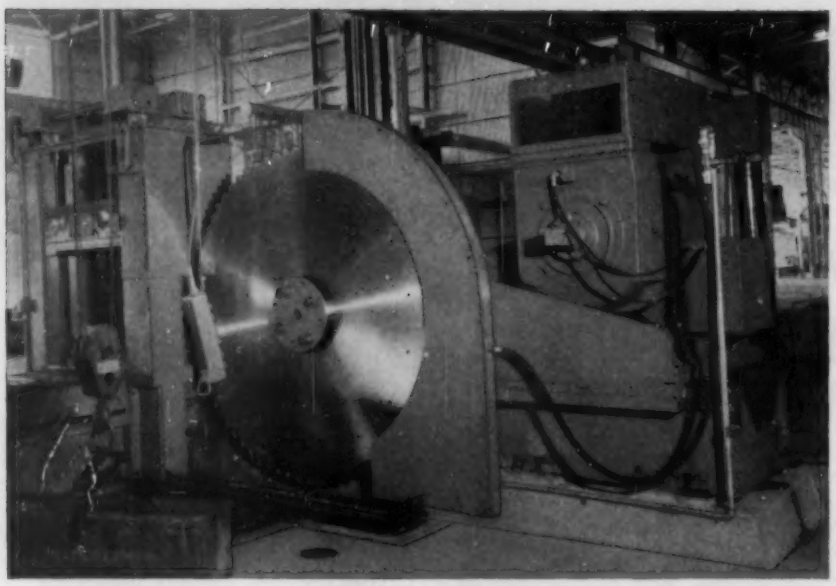
☐ GEA-6200 Tri-Clad '55' Motors
☐ GEC-1031 G-E Circuit Breakers
☐ GEA-4746A SB-1 Control Switch

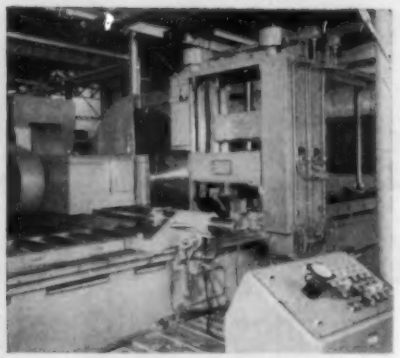
CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME..... COMPANY.....

CITY..... STATE.....

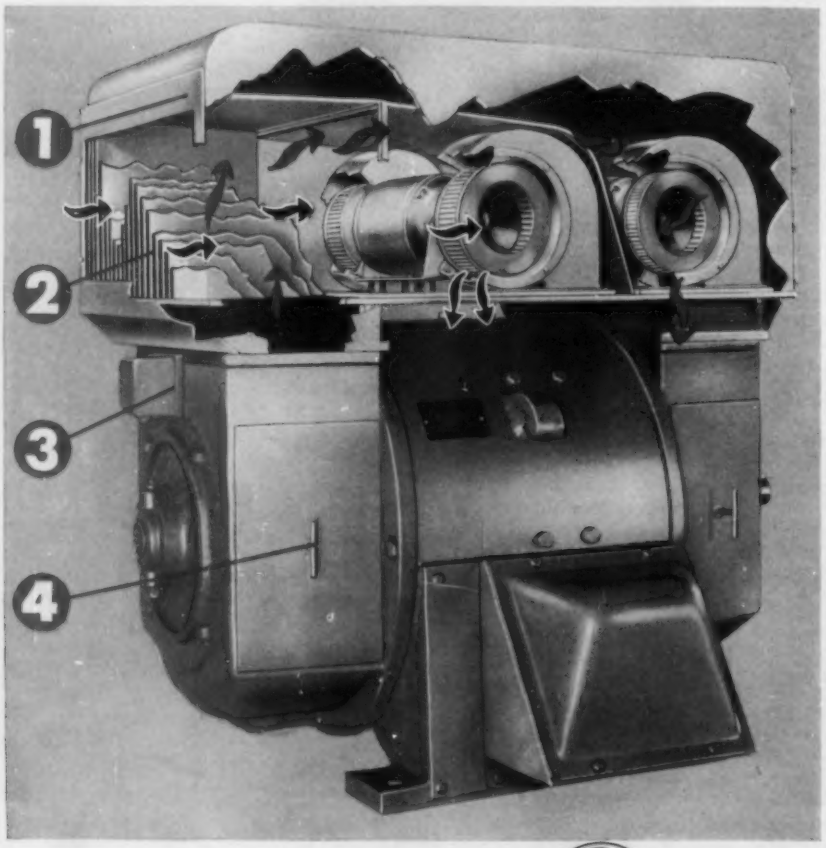
TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS





G.E. ENGINEERED the application of a totally-enclosed unit-cooled d-c motor as a drive for this giant saw. Above, motor is at back left, mounted with saw on movable bed. At left, saw blade is in front, with motor's vent opening in view at top right. Motor is capable of handling blades even larger than the blade shown.

G-E d-c unit-cooled motor drives large circular saw, slices 43″ aluminum ingots



At Alcoa-operated U.S. Air Force plant 47, General Electric's unit-cooled d-c motor helps perform a gigantic operation. Motch and Merryweather's high speed circular saw, largest they have built, is driven by the 150-hp G-E motor, with power supplied by a G-E Speed Variator. Its 84-in. saw blade can cut aluminum forging ingots up to 43 in., and the saw-blade speed is variable from 400 to 3200 surface feet per minute. Because of the fine mist created by the blade in cutting aluminum, the G-E d-c unit-cooled motor was selected to help prevent foreign material from entering and harming the motor.

Compact, easy to maintain, no filters to clean, dependable G-E unit-cooled motors are available at all rated speeds. Where water or moisture, metal particles, dust, dirt, oily vapors, fly ash, or other harmful materials are present, this better-protected motor will effect real operating economies.

At left, four big features are shown:
1. Compact, top-mounted cooling unit falls within length and width of main motor.
2. Smooth vertical plates are self-cleaning.
3. Protective thermostat helps safeguard main motor in case of blower-motor power failure.
4. Easy access to inspection opening—no tools required. Red arrows indicate ventilation arrangement. Bulletin GEA-6091A gives complete details.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

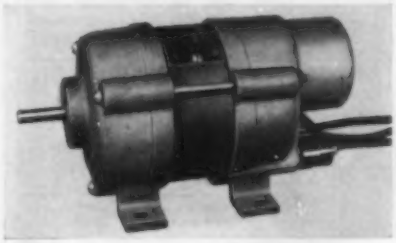
Build in heat with G-E Calrod* heaters in hundreds of types, shapes, sizes, ratings

To help speed your customers' processes and help them reduce costs, a wide variety of General Electric Calrod heaters offer almost unlimited applications in heating surfaces, liquids, and process air and melting metals. Types, illustrated above, include cartridge, fin, strip and tubular. Made from high-quality metals, magnesium oxide, and the finest conductors available, Calrod heaters give long life, dependable service. Today, Calrods are easier to install, more compact, and, depending on the size or shape of your product, you can wrap-around, cast-in, clamp-on or insert Calrod heaters to give you the most efficient method of heat transfer. You may select standard heaters or have them built to your requirements. The heating specialist in your nearby G-E Apparatus Sales Office will help you modernize existing designs or develop new processes. Call him early in your planning for application assistance. Bulletins GEA-5866 and GEC-1005F.

Registered Trade-mark of General Electric Company

G-E selsyns automatically synchronize remote signals or controls

Two or more remote points of a system can be electrically interconnected with General Electric selsyns to provide synchronized control or signals between them, automatically. Compared with ordinary control systems, the time required to transmit readings or actions is greatly reduced. These versatile selsyns can be set up to give accurate indication at several points, and because of their careful design they maintain their accuracy indefinitely. Economical in operation, they require little or no maintenance and do not require specially trained operators. Use them as components for indicating positions of water level, governors, turntables, valves, elevators; for control of material handling, dynamic balancing; for room-to-room and distribution-system signals; and for an extremely wide variety of other devices and systems. For details see GEA-2176C.

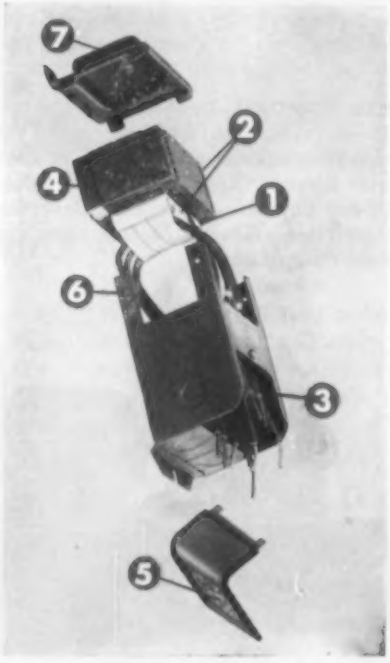


New G-E control transformers: smaller, lighter, more dependable

Featuring 50-, 60-cycle, series multiple operation, these new transformers offer size and weight advantages not only over the previous line but over nine competitive makes. Saves on shipping costs and end-product size. Check these outstanding features.

1. Coil layer-wound with new Class B Alkanex* treated wire. 2. Core and coil pressure-vacuum impregnated for greater dielectric strength. 3. Roomy wiring compartment in 25–2000 va ratings. Available with open wiring in ratings 25–250 va. 4. Unique core design eliminates corner bolts; reduces stray flux and core losses. 5. Wiring diagram printed on cover of wiring compartment. 6. One-piece welded "four-poster" case affords maximum protection for lamination corners. 7. One-piece pressed-steel cap securely locks rigid "four-poster" case design. Bulletin GED-2767.

Reg. Trade-mark of General Electric Co.



General Electric Co., Apparatus Sales Division, Sec. A668-127, Schenectady 5, N. Y.

Please send me the following bulletins: × for reference √ for immediate project

- ☐ GEA-6091A Unit-cooled d-c Motors
- ☐ GED-2767 New Control Transformers
- ☐ GEA-2176C Selsyns
- ☐ GEA-5866 Calrod Heaters for Machinery Manufacturers
- ☐ GEC-1005F Calrod Electric Heaters and Heating Devices

CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME..... COMPANY.....

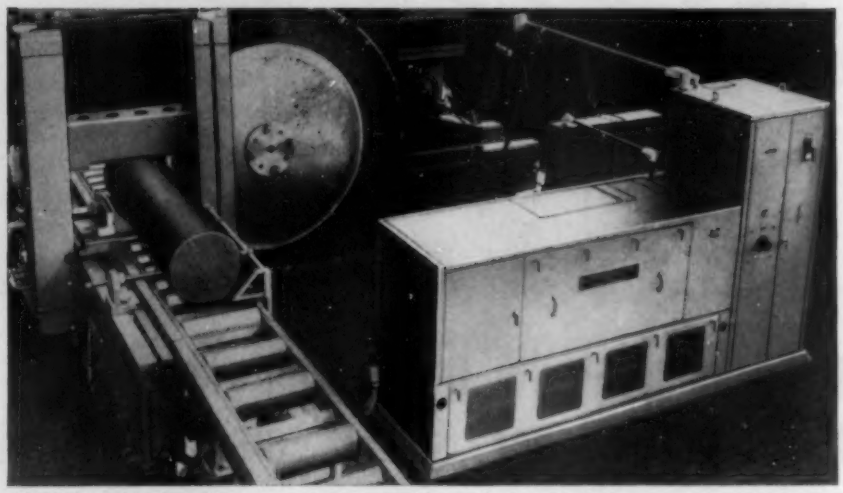
CITY..... STATE.....

G-E Packaged Speed Variator Lowers Production Costs

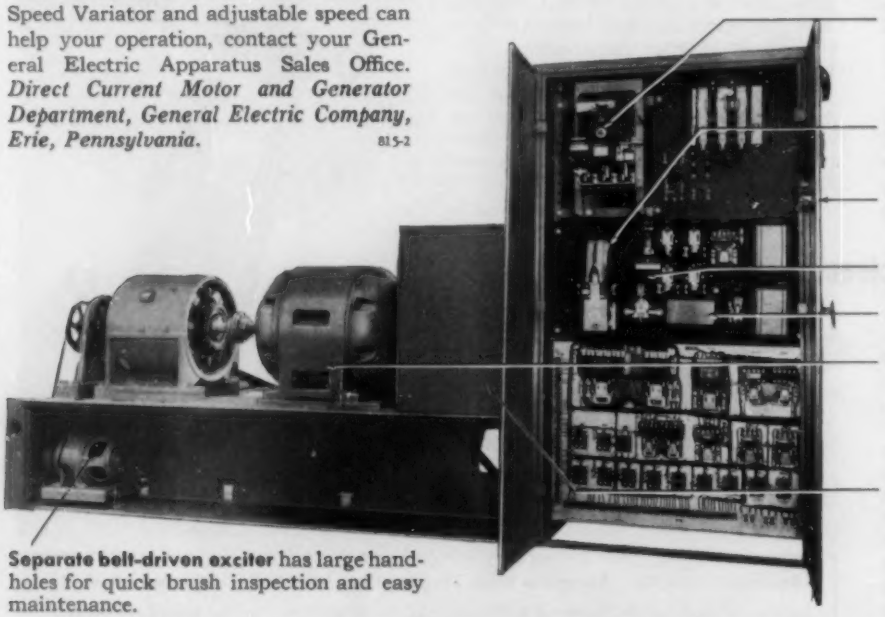
REDUCED PRODUCTION COST per unit machined is provided by the G-E Speed Variator, a packaged adjustable-speed d-c drive operating from a-c power. Supplying constant surface-cutting speeds, quick acceleration, deceleration and reversals, the Speed Variator assures better quality control, increased production and longer tool life. When combined with tracer control, it provides the wide versatility required for automatic processes.

FOR EASY, LOW-COST INSTALLATION, the Speed Variator comes to you completely tested and packaged for your application. Power unit requires no special foundation and may be placed in any convenient location. After simple connections are made between the Speed Variator, operator's control and motor, the drive is ready for operation.

FOR COMPLETE DETAILS on how the Speed Variator and adjustable speed can help your operation, contact your General Electric Apparatus Sales Office. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 815-2



ACCURATE SPEED CONTROL provided by G-E Speed Variator helps boost output, reduce costs when powering high-speed saws (above), lathes, boring mills and many other machine tools.



Separate belt-driven exciter has large handholes for quick brush inspection and easy maintenance.

Electrically operated air circuit breaker provides better protection for a-c motor of m-g set.

Standard, stocked control components utilized throughout for quick maintenance.

Strong, rigid steel cabinet is pressurized to help keep dirt and dust from controls and m-g set.

All devices identified for quick, easy recognition.

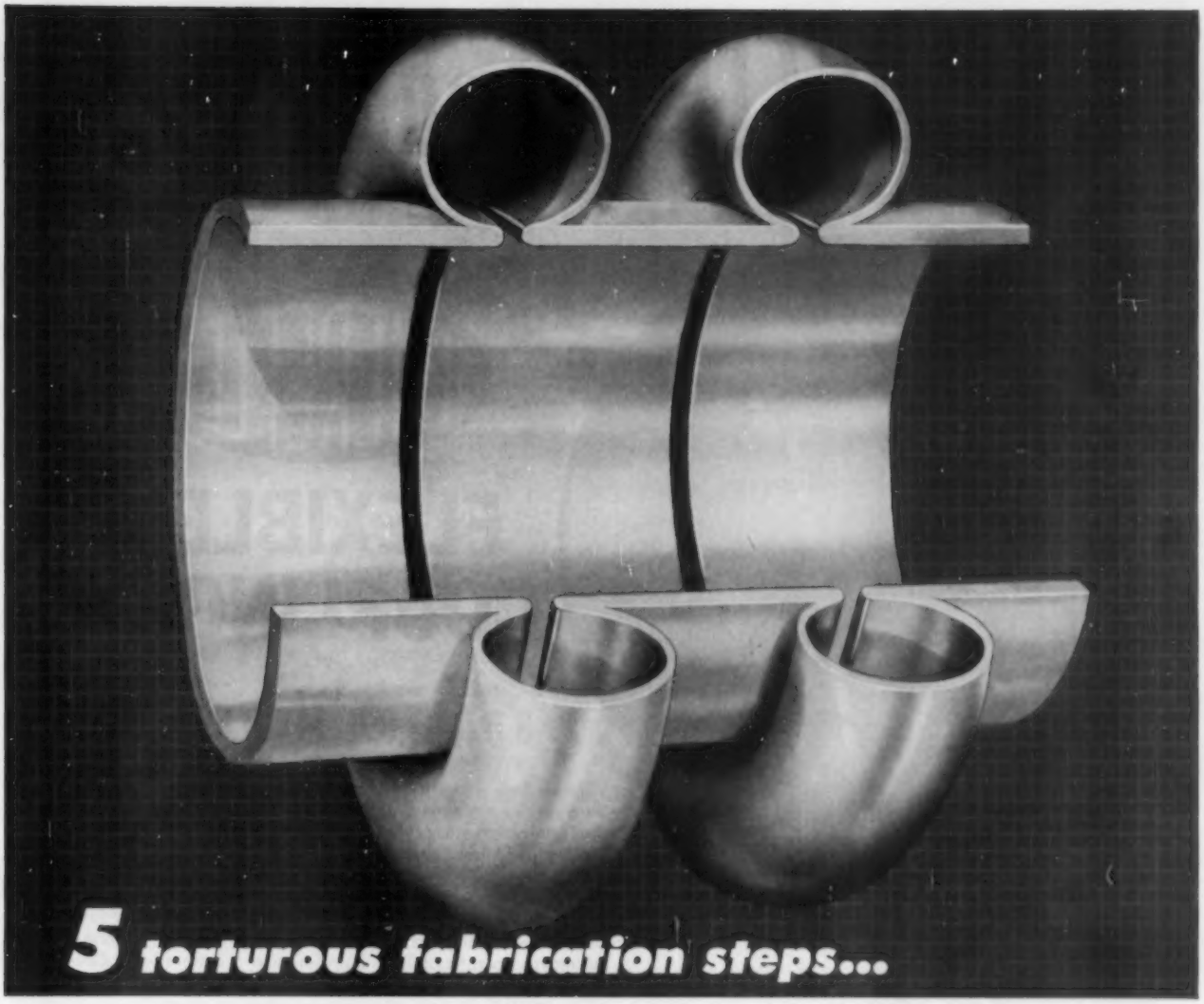
D-c overload protection.

Motor-generator set is of strong construction and alignment is precise. When installed, m-g set is better protected in steel cabinet.

Large fan within enclosure forces filtered air over m-g set and controls for proper cooling.

"E" SIZE SPEED VARIATOR SHOWN WITH M-G SET ENCLOSURE REMOVED.

GENERAL ELECTRIC



Carpenter Stainless Tubing excells in quality and uniformity

Pictured above is a sectional view of a packless expansion joint for pipe lines, pressure vessels, and special requirements. Sizes from a few inches to several feet in diameter have been in service for 15 years at temperatures to 1800°F and pressures to 10,000 psi, and no functional failures have occurred, according to the manufacturer. Unique design and construction advantages, exclusive fabricating techniques, and highest quality materials account for this long record of failure-free service.

All expansion elements (corrugations) in this type of joint are formed from Carpenter Stainless Tubing by five punishing operations. "*There isn't a truer test of tubing quality,*" says the manufacturer. "*It must be perfect in all respects—uniform grain structure, wall thickness, size, soundness, and blemish-free surface. Inferior quality in any one factor will cause failures in fabrication as well as in use . . . Carpenter tubing is the only kind that has rendered consistently failure-free service.*"

Many others, too, have found there is a time-saving, cost-cutting difference in stainless tubing quality and uniformity . . . and Carpenter makes it. So why not apply the advantages of this provable difference to products you design or fabricate? Start by contacting your nearest Carpenter Distributor or Representative for prompt information on your needs.

MEMBER

The Carpenter Steel Company,
Alloy Tube Division, Union, N. J.

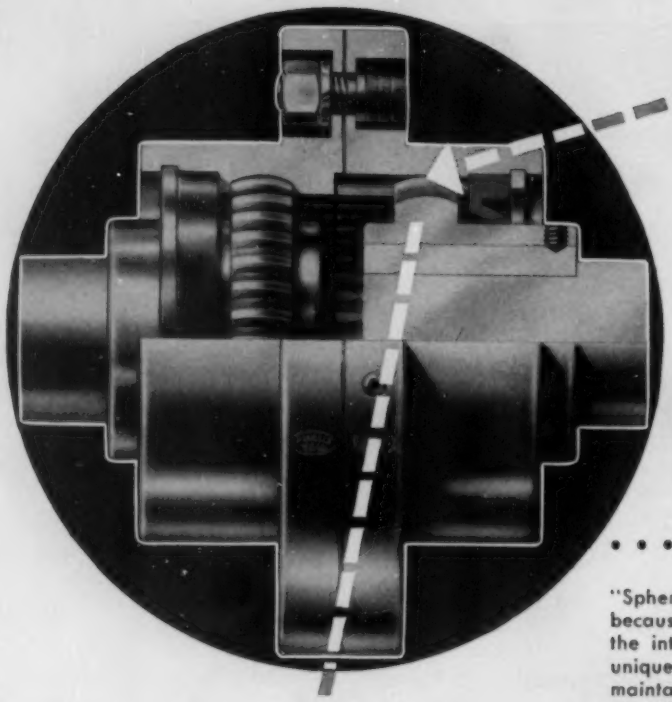
Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter

more than corrosion resistance

Stainless Tubing & Pipe

INVESTIGATE the advantages



SPHEREFLEX®

FLEXIBLE COUPLINGS

...and you'll buy them

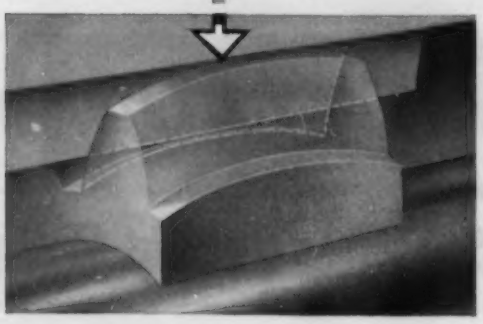
"Sphereflex" is entirely *different* than any other coupling, because the male teeth are cut on a "true spherical arc" and the internal teeth are cut with a "straight root" . . . This unique combination permits the curved teeth to constantly maintain a *full line of contact* with the internal teeth, *even when the coupling is flexed;* in addition, this feature makes it *absolutely unnecessary* to depend upon excessive backlash between coupling teeth, point contact or springs, in order to secure true flexibility. Size for size, "Sphereflex" Couplings will withstand higher horsepowers and greater misalignments than any other comparable couplings.

Standard "Sphereflex" Couplings will compensate for angular mis-alignment up to 3½° plus or minus on each coupling half, or a total of 7°, (special couplings are available for mis-alignments up to 14°). Due to this angular capacity, the "Sphereflex" Coupling can offer much greater parallel misalignment with minimum backlash. "Sphereflex" Couplings are priced competitively with ordinary commercial gear couplings.

When you buy "Sphereflex" Couplings, you secure the background of 64 years in power transmission engineering and experience, covering thousands of jobs in every line of industry and transportation.

If you have a Coupling problem, "Phillie Gear" Sales Engineers can help you to secure a cost-saving and effective solution . . . Phone, wire or write for our new coupling Catalog #C-540.

NOTE—
teeth are cut on a true spherical arc



PHILADELPHIA GEAR WORKS INCORPORATED

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
BALTIMORE • CLEVELAND

Virginia Gear & Machine Corp., Lynchburg, Va.

Industrial Gears & Speed Reducers • LimiTorque Valve Controls

Established 1892

Perspectives

IN DESIGN AND DEVELOPMENT

MAGNESIUM'S FUTURE

The trouble with Magnesium is that it always gets compared with Aluminum. This has been true for a number of years, during which time magnesium came out on the short end. Now, however, designers are taking the properties of this light metal at their face value, and are designing accordingly. Present indications are that its use will be greatly expanded. According to the President's Materials Policy Commission, called the Paley Report, the rate of expansion for magnesium is 1845 per cent from 1950 to 1975. Titanium will have a 324 per cent increase.

Magnesium is the lightest of metals; aluminum is 1½ times heavier, and iron and steel are four times heavier. It follows then, that magnesium would find wide use in the aircraft field. Increased sheet thickness, offering greater rigidity, is accomplished with a saving in weight compared to aluminum. High strength magnesium extrusions have a strength-weight advantage over aluminum. Also, new high temperature zirconium-thorium-magnesium alloys with good strength and creep resistance in the 600-700 F range are of interest to airframe manufacturers.

PROBLEMS IN ACCEPTANCE

The disadvantages of magnesium are what one official in the industry calls "economic." Some of the fabricating procedures are slightly different, and consequently may be more costly than those in general use. With the exception of aircraft and some specialized uses, the saving in weight may not warrant the additional cost. However, the past few years have shown a greater demand for magnesium in commercial products, proving that the problems of fabricating are being solved with experience.

Corrosion is another bogey associated with magnesium, but work is being done with surface finishes to remedy this. Finishes such as epoxide or polyvinyl butyral resins, and synthetic rubber are being developed.

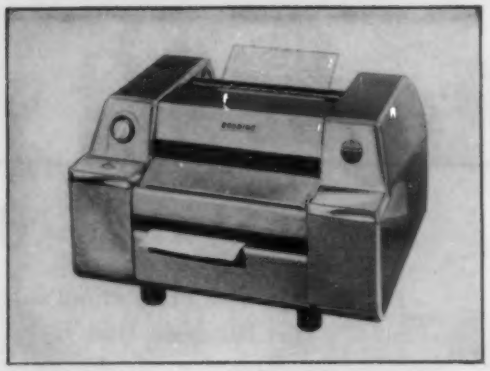
AIRCRAFT USE

Some of the specific applications of magnesium in aircraft were on the B-36 where over 16,000 pounds of the material in all product forms were used. Total weight saving on the entire airframe was 4,000 pounds. Of significance is that large areas on the fuselage contained magnesium sheet in the gage range from 0.016 in. to 0.151 in. which was used as contour skin covering an aluminum substructure. The magnesium was used here as a circumferential stiffener. The Douglas C-124 contained 4,500 pounds of magnesium, and the Boeing B-52 jet bomber used about 6,000 pounds. The Sikorsky H-19 helicopter had 1,800 pounds. Sub-flooring of these planes had extruded magnesium I-beams with a depth of 10 to 11 inches.

Just recently an all-magnesium F-80 jet fighter (wings, fuselage, and tail assembly) was successfully test flown by the Air Force. Built by East Coast Aeronautics, Inc., the plane is now undergoing final flight tests at Wright Air Development Center. Although the plane was orig-

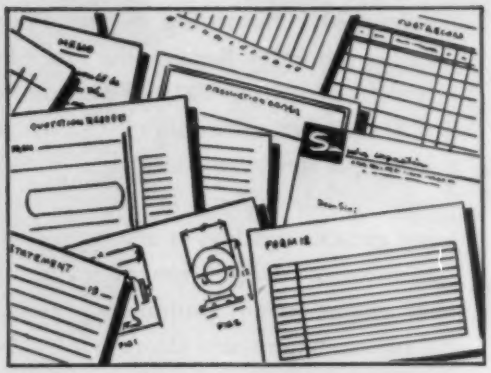
(Continued on page 125)

Why Bodine motors were selected for Bruning Copying Machines



1 This is a new desk top copying machine. It's called the Bruning Copyflex. It will make 300 copies an hour at less than 2¢ a copy.

2 This neat, well dressed young lady is fond of the Copyflex because no stencils, no negatives or no messy inks are needed.



3 She can grind out facsimile copies of letters, invoices, reports...practically anything typed, written or printed...in just a matter of seconds.

4 As you might guess by now, the Bruning Copyflex is powered by a Bodine motor. This is it ...a type NSH-11R ball bearing, reducer motor.

5 This is Mr. John P. Arndt, Works Manager for the large Chicago factory of the Charles Bruning Company.

"The reason we use Bodine Electric Motors is because we could not buy a product of equal quality elsewhere They make an excellent product, and this is about the only reason I can give why we buy their motors."

6 Considering that the motor is the heart of the product, Mr. Arndt's reason for using Bodine motors makes good sense...see above.

BODINE

50th Anniversary

BODINE

fractional horsepower

MOTORS

7 Be sure your motor is as good as your product. For information contact Bodine Electric Co., 2260 W. Ohio St., Chicago, Ill.

BODINE MANUFACTURES FRACTIONAL HORSEPOWER ELECTRIC MOTORS FOR:

adding machines
letter openers
sanders
vending machines
exhaust fans
duplicating machines
portable tools
sound recorders
air conditioners
check protectors
respirators
voltage regulators
x-ray timers
traffic signal timers
stirrers
calculating machines
envelope sealers
diesel governors

. . . and for many other applications.

Ask for a sample copy of "The Motorgram," a bi-monthly publication discussing application and design of fractional horsepower electric motors.

inally designed for aluminum, the substitution of magnesium made many significant points. The thick-skinned wing and fuselage construction reduced the number of structural parts and fasteners, saving man-hours in construction. Elimination of stiffeners in wings made possible a 30 per cent increase in fuel capacity, and a cleaner aerodynamic surface (fewer rivets and reduced surface buckling in the thicker skin) boosted speed by 10 mph and improved performance. Increased wing rigidity is a result of magnesium skin thicknesses of from 0.064 to 0.375 inch. The thickest skin on the aluminum wing was 0.051 inch. East Coast figures that a plane designed from the beginning for magnesium construction would be 20 per cent cheaper to produce.

WHAT NEXT?

The next move is anyone's guess. At Wright Field engineers have a high regard for the magnesium design, and the research group at the Air Research and Development Command agree. At the Pentagon the Air Force is non-committal, saying that tests will continue, and that their interest in magnesium is still as a substitute material. Also, there are no plans for further design and production of all-magnesium planes.

WHAT AIRCRAFT MANUFACTURERS SAY NOW

In an interview of West Coast plane manufacturers last month regarding the use of magnesium on their future planes, almost all the answers were not to magnesium's advantage. As for all-magnesium plane: it was an interesting experiment, but not for them. The materials as well as the fabrication techniques, they say, were every bit as expensive. Use of magnesium in their future planes is definitely declining. Small magnesium castings will be used, but not skin, sheet, or extrusions. They prefer to extrude integral stringers in aluminum to thick magnesium skin. Still another headache with magnesium is corrosion. Because of this, the companies plan to replace such items as floor beams with aluminum. Training personnel to work with magnesium is another added cost, they say.

NEW MAGNESIUM APPLICATIONS

Although the aircraft business is slipping, magnesium people point to production figures and say that more of the metal is being used each year for: housings for electronic devices; rocket wings and skins; luggage; loading platforms; ramps and ladders; printing plate; transportation industry (trucks and trains); tooling plate; cathodic protection; and many more. Dow Chemical's improved hot chamber die casting machine will make magnesium competitive with aluminum and zinc die castings.

MORE COMPETITION NEEDED

Perhaps the big problem with magnesium is the lack of competition. Dow Chemical Co. is the major producer of magnesium, but cannot expand further for fear of getting in trouble with the Justice Department. There are a number of government plants kept in standby condition which can be leased, but they are outmoded and cannot be operated profitably by a private concern. Also, new plant investment is too high without government help. Such a situation should rectify itself in several years when the demand is greater, and more technical problems have been solved.

Engineered by Tinnerman...

NEW SNAP-ON MOTOR CLIP REPLACES 4 PARTS

Cuts Assembly Time and Costs!

If you manufacture or use fractional horsepower motors, this new Tinnerman SPEED CLIP® can lower your parts and assembly costs by eliminating 4-piece screw clamps to hold motors in place.

Made of high-quality spring steel, this SPEED CLIP is quickly snapped into place over the resilient motor-mounting ring, using a simple hand tool. It forms a vibration-proof lock that won't shake free. Assembly time is reduced because of the one-piece construction . . . no loose parts to handle, nothing to tighten. Parts cost and assembly cost are reduced as much as 75%!

These SPEED CLIPS can be provided in sizes to fit any fractional-horsepower motor. They are designed to hold tight even under severest vibration and high starting-torque in any mounting position.

Ask your Tinnerman SPEED NUT sales engineer for more information and arrange for samples to test on your own assembly line.

TINNERMAN PRODUCTS, INC. · Box 6688, Dept. 12, Cleveland 1, Ohio
Canada: Dominion Fasteners, Ltd., Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN **Speed Nuts**®
FASTEST THING IN FASTENINGS®

The Real Test

PERHAPS THE MOST IMPORTANT work of the design engineer is to create a new product that will function satisfactorily. Usually the first model operates but not to complete satisfaction. It might be erratic or too slow. Perhaps some of the elements of the machine wear out too rapidly. Or the machine may be relatively inefficient.

Having brought a new born babe into the world, it is quite natural that the designer concentrates on its further development in order to achieve a product that will function as nearly perfectly as possible. Perhaps the best known example is the Model T Ford. Its sales slogan was "It Takes You There and Brings You Back." The implications of this slogan were quite warranted, considering the performance of automobiles of that day.

When the curve of product operating efficiency and performance begins to flatten, the purchasers and prospects begin looking for other improvements. The wise engineer keeps himself alert to this fact. He avoids digging a rut in the field of technical excellence. His mind starts dwelling more and more on the possible improvements in other channels.

Again taking the automobile as an example, it is difficult to bring to mind any other product which has been improved in so many different directions and so intensively and steadily. At various times the endeavor was to improve starting, beauty, riding comfort, lighting, safety and then a series of major features in the direction of ease of operation that finally led to the fluid couplings, hydraulic drives and hydraulic steering. Many other products followed paths of improvements comparable to those of the automobile.

Designers often do not recognize the importance in the eyes of the customer of features that seem to be nothing more than minor irritations and minor discomforts to the designer. He may think little or nothing of getting on his knees to do some oiling. Or he may consider the discomfort of manipulating controls as a necessary evil. But the alert designer will be quick to realize that the buyers and users of his product will, consciously or subconsciously, appreciate every little feature that makes the product more pleasing to behold, easier to operate, less difficult to keep in running order and comfortable to use.

The three levels by which products and services can be judged are necessity, comfort and luxury. The wheels of a factory can only turn as long as the designers of the products it manufactures reach out to the higher of these levels. The designers must always bear in mind that the luxury features that they put into the product last year have now become comforts that replace the comforts that now have become necessities. The real test of engineering design ability is not merely to develop a new product but to do that and then improve the design repeatedly so that it will always meet, or even anticipate, the ever mounting demands of a critical clientele—the buyers.

George F. Rockwell

NEW DEPARTURES OF TOMORROW

TOMORROW: You dictate! The machine types and hustles your letters to the mail. Electronics does it all.

Think of dashing through your correspondence with this imaginary scribe! It converts your voice into electronic impulses which type, micro-record, fold, insert, seal, address and stamp letters almost as fast as you can dictate!

It's just a notion now! But when some foresighted engineer works it out, you can bet New Departure will be called in to design the right ball bearings to keep these intricate parts working smoothly. New Departure works with engineers right from the planning stage to develop the exact bearing for even the newest departure in design.

Whether you're planning a new product or redesigning an old one, call on New Departure. You'll benefit from a half-century of experience.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

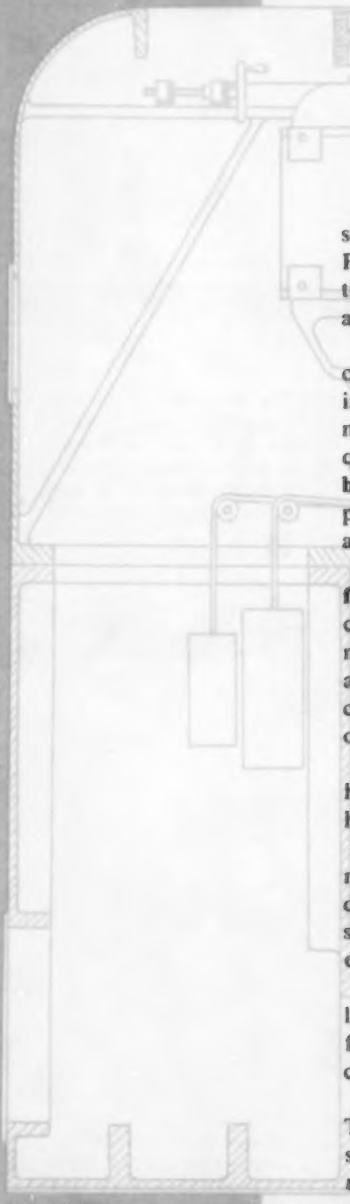
TODAY: In dictating instruments, New Departure ball bearings contribute to compactness of design and operating efficiency. They hold moving parts in alignment—reduce wear—require no upkeep.

NEW DEPARTURE
BALL BEARINGS
NOTHING ROLLS LIKE A BALL

Selected designs of

MACHINE ELEMENTS

How machine tool designers are solving their problems of constructions, power controls and transmissions, surface protection, hydraulics and pneumatics.



W. B. Knight Machinery Co.

Machinery design is basic. Independent of the purpose for which a machine is designed, solutions to the specific problems are the same for the same requirements of service. For given speeds, loads and ambient conditions on a journal, the solution to the lubrication problem is based on the same fundamentals, whether it be production machinery, automotive equipment, or railroad rolling stock.

It is relatively simple to design for common conditions. Heavy vibrations may be of no consequence in a bulldozer whereas even small vibrations in machine tools may prove intolerable. Over lubrication of a moderate speed, lightly loaded spindle on a packaging machine may have no appreciable effect in a piece of store equipment but may well require a production machine to be put off the line. Summarizing, **machine tool design must be best from every angle.** Strength, rigidity, absence of vibration, perfect lubrication, protection against ambient conditions, dependability of controls, and ease of operation are required in every machine tool.

Every problem in engineering design is solved by the application of the same design fundamentals, and the method of their application will be almost identical. Wherever a component is applied to serve a stated purpose, a similar component applied in a similar manner will serve a comparable purpose on a vastly different machine. The design of accordion boots will serve equally well on a milling machine or a bottling machine. A central lubricator does not know or care if it is on a rolling machine, milling machine, or open side planer.

With these thoughts in mind, editors of *Product Engineering* carefully studied the exhibits at the Chicago Machine Tool Show. Their sole purpose was to observe and record how machine tool designers had solved specific and pressing problems.

Naturally, there were often a number of different solutions to the same problem. Thus, machine ways were protected against chips and dirt in many ways. At least four distinctly different methods were recorded. In other instances, only one method of achieving a stated objective was recorded because it was considered that this was the only one of exceptional note, or that it was representative of a type.

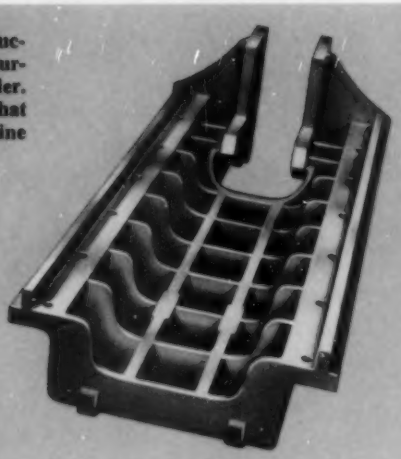
Several over-all trends in machine tool design were obvious to most observers. Signal lamps are being used much more extensively. Many more gages and instruments are now found on machine tools as compared to the 1947 show. Built-in lighting is becoming a common feature.

True to all advance reports, automatic controls are getting a great deal of attention. This does not mean that automatic control is entirely new to machine tools. Automatic screw machines have been in operation for many decades. The Hydrotel and the Keller machines are now old timers, both machines still in the front rank for die sinking and similar jobs. Profiling machines are not new. But in this recent Machine Tool Show there was a big jump in the degree to which servos and automatic controls are being applied.

Although all the designs of machine elements shown here relate to machine tools, it should be emphasized that the same techniques, components or design principles are applicable to any other machine that encounters the same or similar operating requirements.

Copyright 1955 by McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York 36, N. Y.

Integral cast base, bed and frame designed by the Landis Tool Company. The bed walls are placed directly under the carriage ways for better rigidity and to minimize misalignment. Note integral side mounting pad for auxiliary equipment and large openings for ventilating to maintain an even operating temperature.

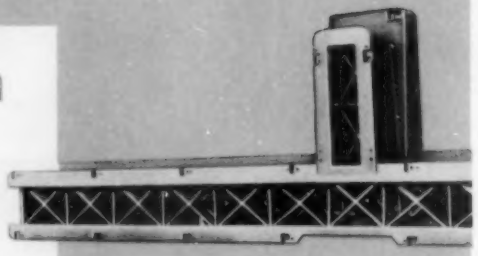


Heavy ribbed casting construction on Taft-Pierce Manufacturing Company surface grinder. Such construction typifies that used on almost all the machine tools at the show.

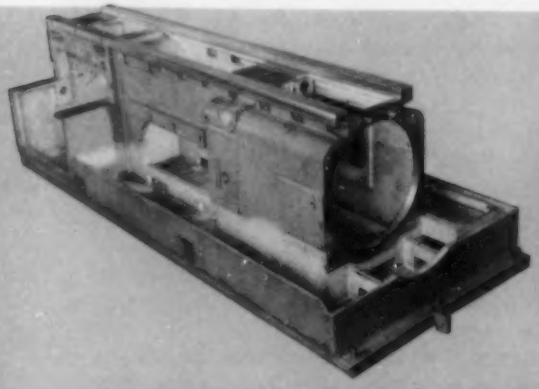
Machine Construction and Materials

CONSTRUCTION TREND APPEARS TO BE toward heavy, massive, integral cast iron bases, frames and beds. Only a few of the machine tools seen (and then mostly the larger presses or very long bed machines) use steel weldments. Almost all bases, frames and beds are ribbed and reinforced. Major effort is to minimize vibration and the possibility of any misalignment.

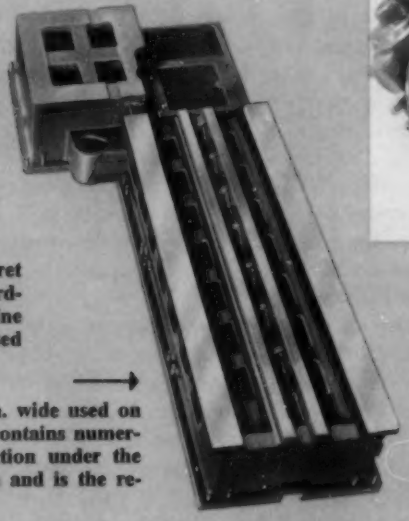
Much of the auxiliary equipment is cast integral with the base, frame or bed. This includes lubrication troughs, lubricant reservoir chambers, motor mounting pads and control panel pads. In almost all instances auxiliary equipment is easily accessible for maintenance yet rigidly mounted for operation.



View of the underside of the Ex-Cell-O Corporation thread grinder. 30 ft table is a steel weldment, heavily cross ribbed and constructed. Provisions are made on all machine tools for jackscrews and hold down bolts.

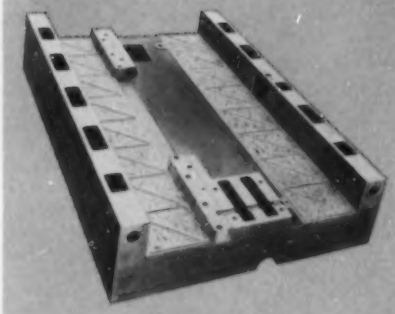


Steel weldment bed of Potter & Johnston turret lathe. Ample ribbing is provided. Ways are hardened and ground tool steel, bolted to the machine base. This is one of the few steel weldments used for the smaller type of machine tools.

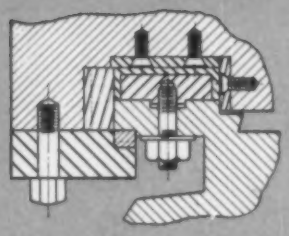


Semi-steel box shaped casting 36 in. wide used on the Cincinnati Gilbert Borer. Bed contains numerous chip chutes cast in place. Section under the column has a solid bottom surface and is the reservoir for cutting coolant.

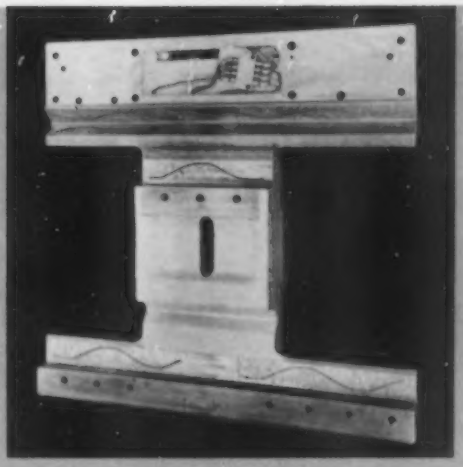
Machined and finished castings on upper portion of a Brown & Sharpe miller. In almost all instances castings are stress relieved before finish machining.



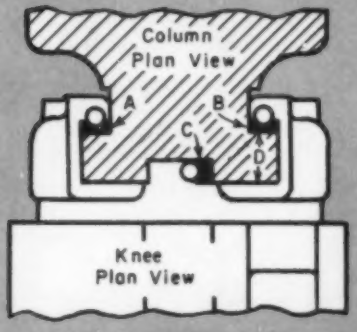
Typical of a phenolic liner on a way is the one shown on a Pratt and Whitney miller bed. Bearing surfaces of phenolic-to-metal will not pick up chips and score ways; wear is minimized; trouble free operation is assured and the original high accuracy is preserved.



Hardened and ground tool steel bonded to soft steel way of flat construction. Both table and carriage ways are removable for replacement if necessary. Design shown is used on Potter and Johnston machine tools.



Underside of carriage of a Monarch Lathe showing a typical method of lubricating ways. Wavy grooves carry lubricant to all parts of the bed and carriage. These carriage ways have been hand scraped to ride on flame hardened and ground bed ways.



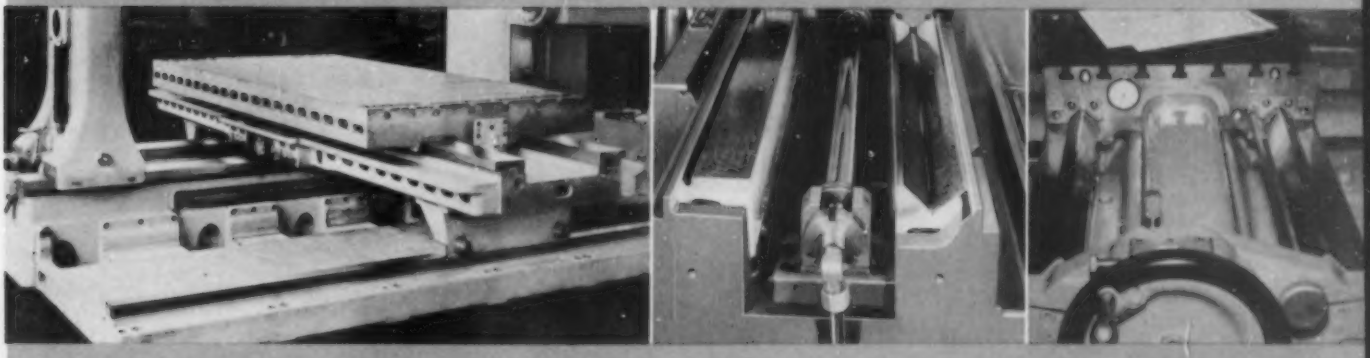
Wide rectangular ways used on column of Cincinnati Milling Machine. Wide rectangular ways give a square deep grip that resists twist caused by milling cutter. Note full three position gibbing, A, B and C. Depth of grip, D, is 6¼ in.

Machine Ways

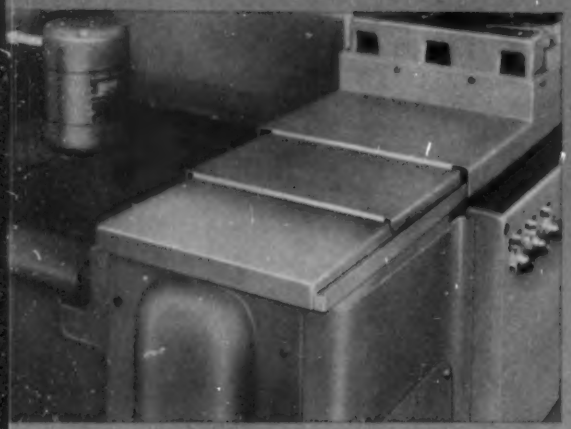
MACHINE WAYS RANGE FROM phenolic inserts to hard chrome plated steel. General trend appears to be for cast iron or steel insert ways although many machine tools feature plastic ways usually on the carriage running against steel. Plastic ways appear to be one answer to the age old problem of scoring and wear. Any chips falling on the way become embedded in the soft plastic.

Almost all machines feature force feed lubrication to the ways. Ways are joined to the machine in such a manner that they are generally replaceable.

Flat and Vee ways are featured. Often a machine will have one flat and one vee unit, however, many machine tools are using either flat or vee exclusively.

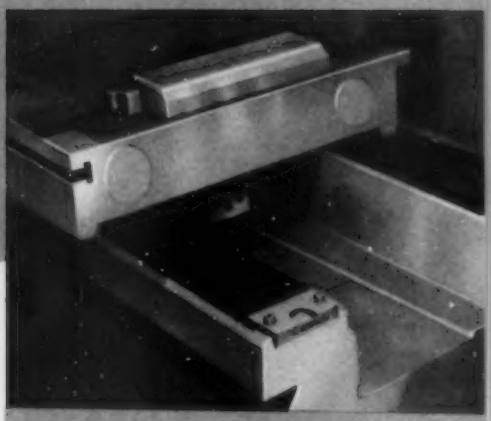


Typical machine ways of the flat and vee type. Flat ways are on a Gidding and Lewis horizontal miller. Large flat areas for heavy equipment appear to be preferred. Vee ways are used on Kearney and Trecker machine tool. Note bronze scraper units for cleaning machine way of chips and foreign matter. Combination flat and vee way used on a Landis Tool Company grinder.



Telescoping way covers protect the hand scraped bed ways on the Landis Tool Company grinder from dirt and grit. Covers are stamped and flange connected. Any cover can be lifted out and easily replaced.

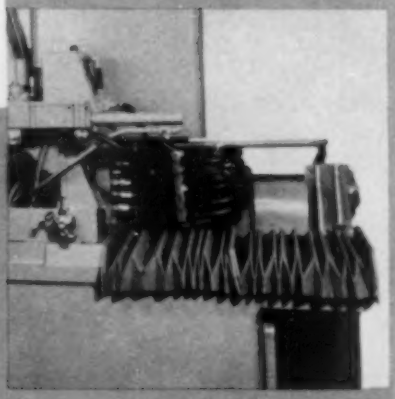
Telescoping way design on a Cleereman Machine Tool Company jig borer. Covers are steel stampings.



Spring steel strips are used to cover the table ways on the Norton Company cam grinder. Covers roll and unroll into the traveling bed of the machine.

Protective Components for Ways

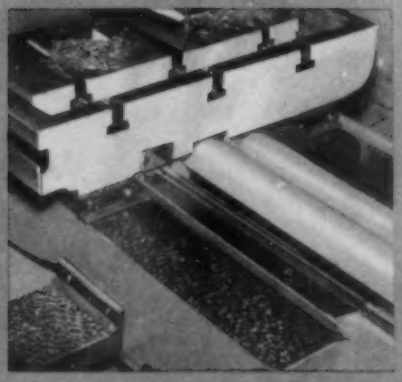
WAY PROTECTIVE DEVICES range from spring steel units to strips of impregnated fabric. Many machines use wipers of phenolic, neoprene, leather, bronze and other materials to clean the ways of chips and other matter. Bellows are in use on machines as both way covers and spindle drive covers.



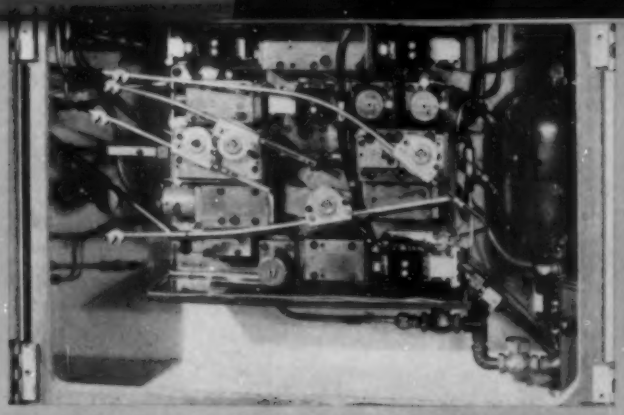
Impregnated fabric that accordion pleats as the machine bed travels. Note setup of hydraulic lines that also must move with travel of table. Design used on Geargrind machine.

Weighted plastic-type way cover as used on a Knight Machinery Company jig borer. Cover runs over rollers attached to side of table. Impregnated fabric bellows are used on machine spindle drive. Steel band has been tried as way cover but tends to fail after extended use through fatigue.

Bellow type way covers of woven neoprene material used on Frauenthal Div. double head grinder. Note separate control panels for heads.

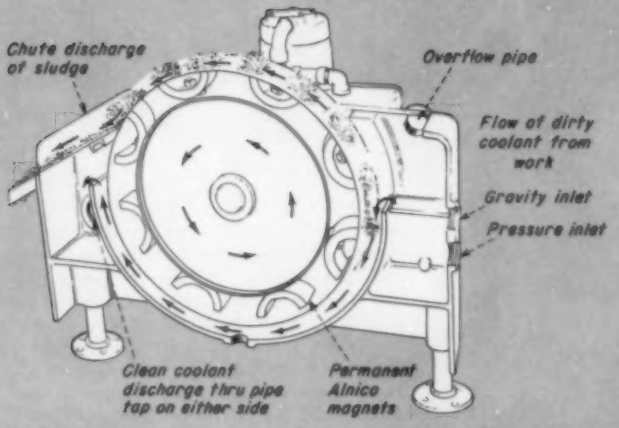


Typical scraper unit used for cleaning machine ways of chips. Neoprene scraper is cut in shape of an angle, one side being screwed to machine table. Scraper is preloaded against machine way. Design is used on a Cleereman Machine Tool Company borer.



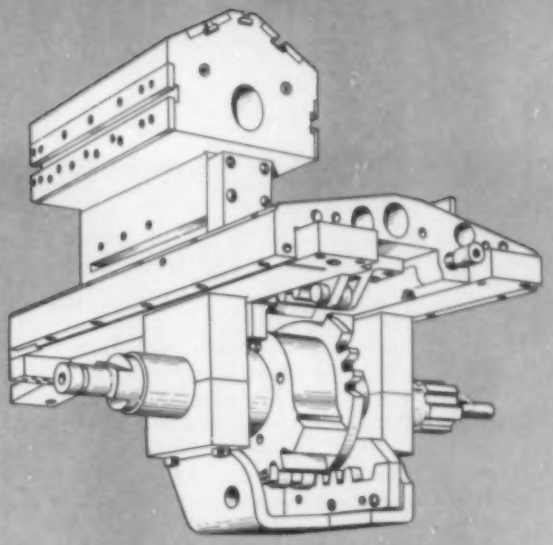
Flexible cables of push-pull type used on Brown & Sharpe grinding machine to set positions of hydraulic control valves. Control knobs are grouped in central control panel in front of machine.

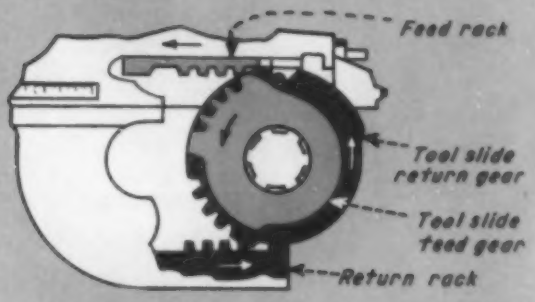
Mechanisms


Chute discharge of sludge
Overflow pipe
Flow of dirty coolant from work
Gravity inlet
Pressure inlet
Clean coolant discharge thru pipe tap on either side
Permanent Alnico magnets

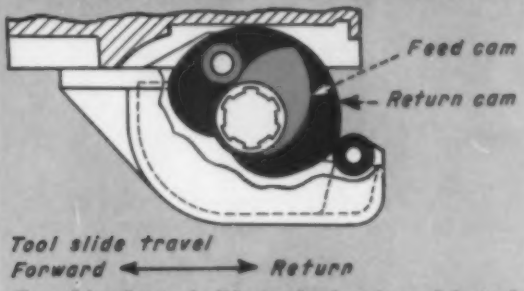
Permanent magnets remove chips from coolant in magnetic separator produced by Barnes Drill Co. Cross sectional view shows flow channel, arrangement of magnets and construction details.

Standard line of roller gear indexing drives is produced by Ferguson Machine & Tool Co., Inc. for high speed precision indexing. Illustration shows a 12 stop standard unit and housing designed for any combination of directions of rotation and can be mounted in any position and fastened by any of five sides.



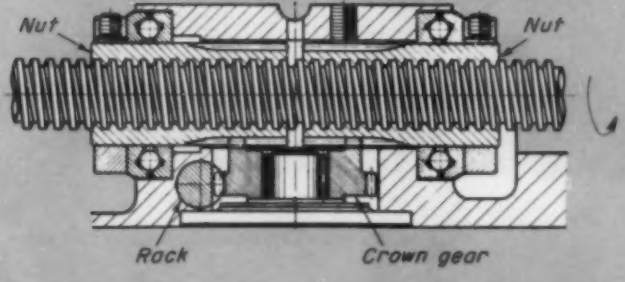


Two-directional rack-and-gear drive for main tool slide combines accuracy, uniform movement and minimum idle time. Mechanism makes a full double stroke per cycle. It approaches fast, shifts smoothly into feed and returns fast. Point of shift is controlled by an adjustable dog on a calibrated gear. Automatic braking action assures smooth shift from approach to feed. Used on Greenlee 4-Spindle Bar Automatics.

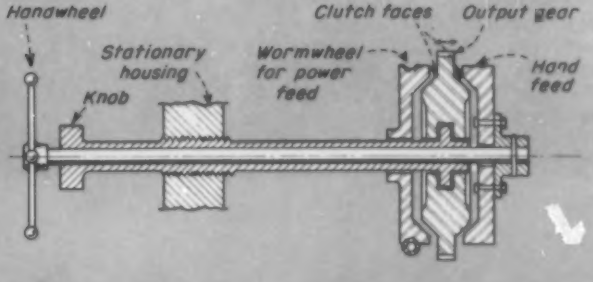


Cam drive for tool slide mechanism is used instead of rack feed when short stroke is required to get fast machining cycle on Greenlee Automatic. Sketch shows cams and rollers with slide in retracted position.

Automatic backlash eliminator operates during both directions of table feed screw. Moving rack in or out rotates crown gear, which tends to rotate two independent nuts in opposite directions. Used on Cincinnati Dial Type Milling Machines to eliminate backlash during both down milling and up milling.



Knob moves double face clutch axially to select hand or power feed on Pratt & Whitney jig borer. Threaded shoulder on tube engages tapped hole in stationary housing to shift clutch position. Both drives are through metal-to-metal contact.

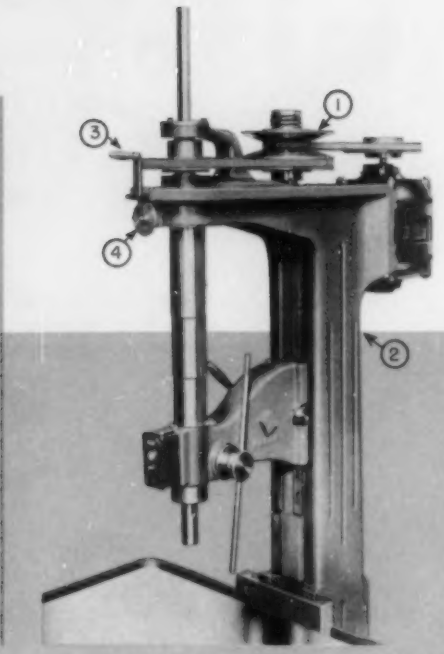


Power Transmission

WHERE POWER IS REQUIRED to drive two or more components, the tendency is definitely toward the use of separate drive units. The majority of main drive motors are 220/440 v a-c. D-c motors are used occasionally but it was more common to find an a-c main motor with a separate d-c drive used to provide variable speed for a spindle or table.

Multiple V-belts far outnumbered other methods of transmitting power from the main motor to the gear box. However, several applications of Gilmer timing belts were noted, at least one section-leather belt (see illustration), and one Poly V-belt. Chain drives were encountered only in special forms of heavy duty equipment.

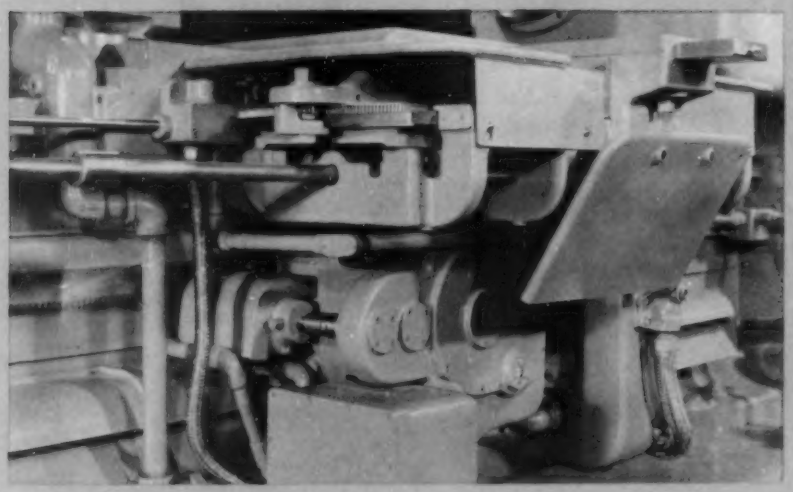
To provide maximum capacity and accuracy with minimum noise and vibration, gears are often made from alloy steel, hardened and shaved.



Spindle drive on Baker Bros., Inc. drilling machines consists of a variable speed pulley unit (1) which incorporates three interlocking pulley sections to form a two groove V-belt pulley. Pulley is carried on a sliding shaft member mounted in the top of the upper frame. (2) As this sliding member is moved from front to back by hand crank (3), the center section of the pulley unit (1) moves vertically. (4) Indicator gives direct speed reading at pointer.

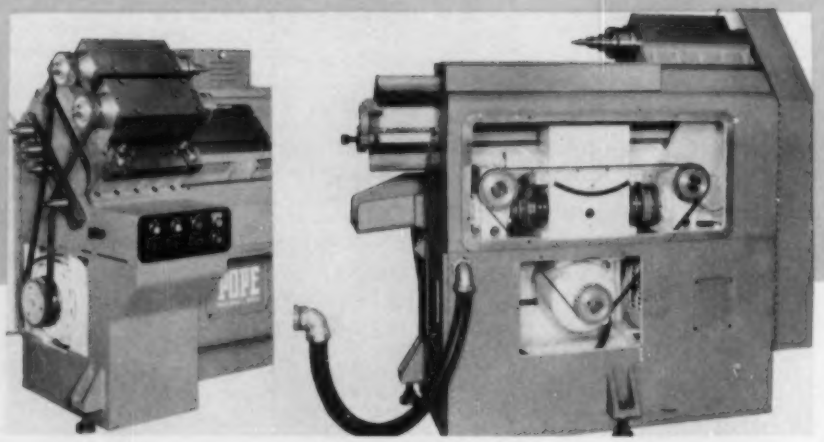
Vertical movement of this pulley section causes one groove to widen as the other narrows, thereby changing the relative pitch diameters formed by this unit.

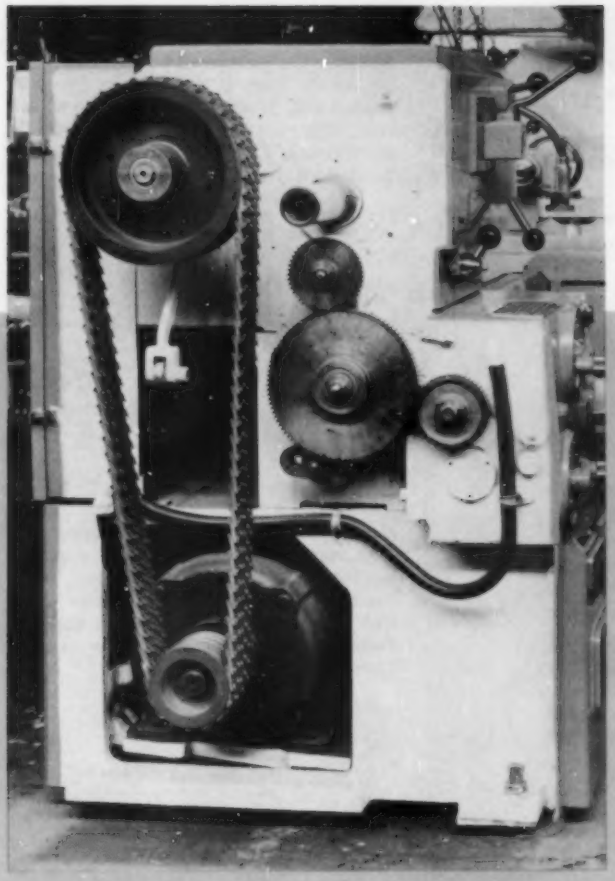
To insure perfect belt alignment at all speeds, the variable speed pulley unit slides on an inclined plane. An adjustable spring tension above the top pulley section serves to maintain power belt tension and absorb sudden shocks due to change in load. Speed range can be changed at any time by changing the motor pulley and the motor belt.



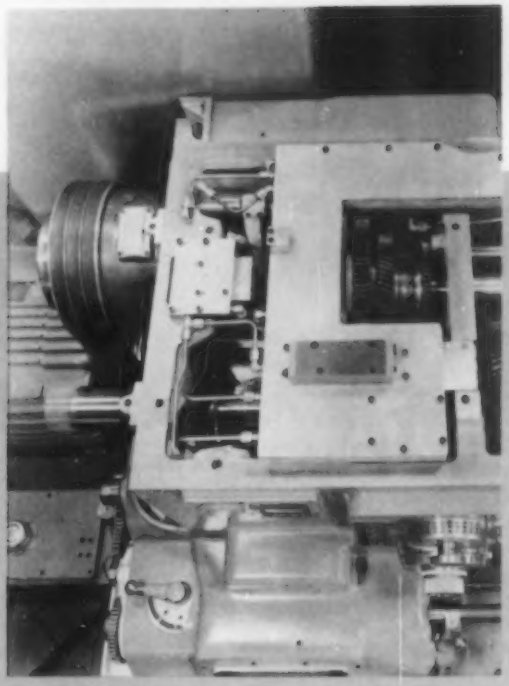
Motor driven unit hung from rear of carriage provides power rapid traverse in both directions at rate of 185 in./min in new Monarch Series 90 Dyna-Shift lathe.

Gilmer timing belt gives positive, smooth and quiet drive for twin spindles of Pope boring machine. Table drive (right) is from electric motor through Gilmer timing belt to two speed reducers designated "feed" and "traverse," and thence by selective use of d-c electric clutches to a third speed reducer which incorporates the table drive drum. This cylindrical drum is connected by a mechanically tensioned precision roller chain to each end of the table thus converting the rotary motion of the drum to move the table to and from the work under preselected electrical control. No sprockets, cams, gears or linkages are used.



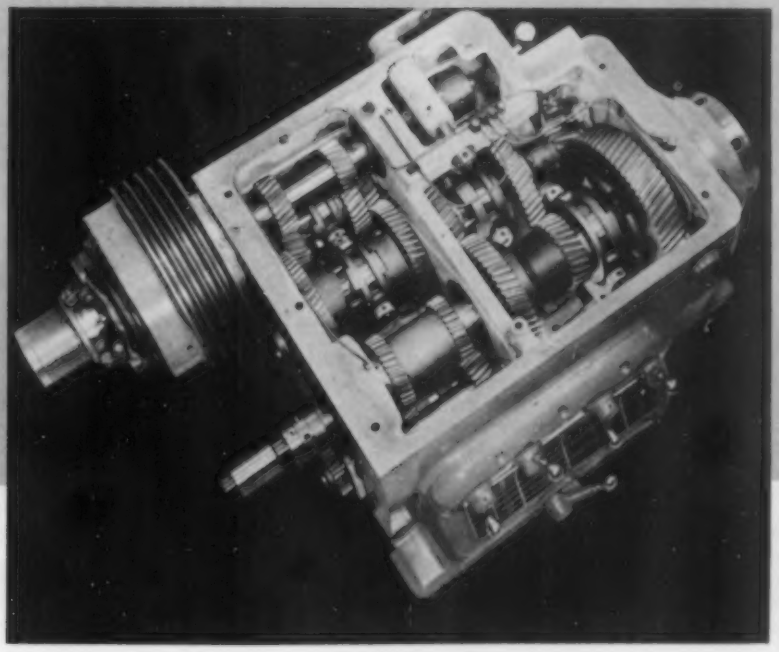


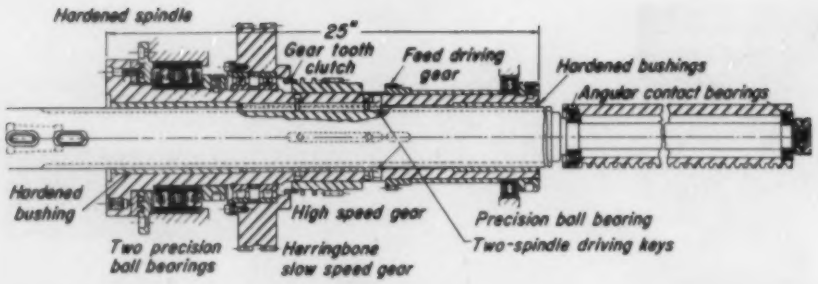
Sectioned-leather belt used instead of V-belt on Springfield Machine Tool Co. Model 280 Lathe.



Multiple V-belt unit of Monarch Series 61 Engine lathe is typical of most main drives. Main drive motor is inside cabinet leg and mounted on hinged plate to change belt tension. Drive clutch is mounted on its own support, and multiple disk brake is controlled by dual levers; one at left hand end of bed, one at apron. As control lever is pulled through a short arc, it passes from clutch to neutral to brake position.

Multiple V-belt drives headstock for Monarch Series 61 Lathes. Hardened and ground helical gears are used throughout. Spindle and all shafts are hardened and ground steel, with ground threads and integral milled and ground splines. Spindle and all shafts mounted on anti-friction bearings which are lubricated by forced feed system. Gears are splash lubricated. Spindle speed changed by sliding heavy-sided jaw clutches.





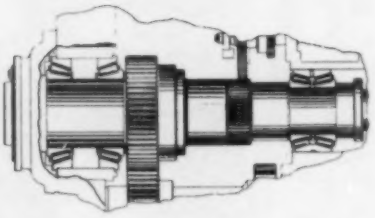
Spindle sleeve for Cincinnati Gilbert Horizontal Boring, Drilling and Milling Machine is a heat treated alloy steel forging 25 in. long. It revolves on two preloaded ball bearings mounted front and rear. The rear bearing floats endwise in the housing. The sleeve has hardened and ground alloy steel bushings in both ends.

Bearings

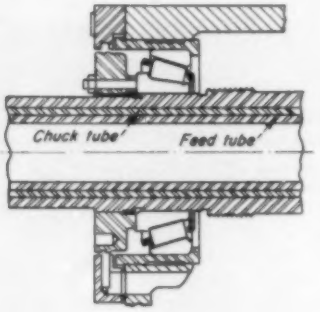
WITH BUT FEW EXCEPTIONS, the machine tool industry has converted from plain to anti-friction bearings. Gears, shafts, cams, clutches and electric motor drives are almost exclusively equipped with ball bearings. Spindles may have ball, roller or tapered roller bearings depending upon the speed and thrust loads. For heavy duty operation at moderate speeds, at least one roller bearing is generally used. For high speeds, and light loads, precision and superprecision grades of ball bearings are common.

To assure smooth operation and eliminate radial and axial play many manufacturers are incorporating preloaded types of anti-friction bearings. A preload is defined as a load which acts through the balls before an external load is applied to the bearing. The primary purpose of a preload is to reduce axial and radial movement within the bearing under applied load. The amount of preload is a compromise between attaining the desired axial rigidity and holding to a minimum the adverse effects of the preload remaining in the bearings under operating conditions.

Most motor bearings and many spindle bearings are greased for life and sealed. Beside avoiding lubrication problems, these bearings can also simplify design and avoid problems of over lubrication. Unless the speed is exceptionally low, a large quantity of grease can be highly objectionable. An excess of grease increases churning action which may lead to overheating and possible breakdown of the lubricant. The tendency to churn is dependent upon the consistency of the grease, bearing design, housing construction and the quantity of grease used.



Heavy duty precision spindle designed for high accuracy and rigidity is mounted in double roller bearings front and rear. Front pair is preloaded to eliminate radial and axial end play. Spindle is used in Potter & Johnston Automatic Turret Lathe.



Semi-flexible mounting for precision roller bearings compensates for expansion that may occur at high speeds. Sufficient clearance is left on OD to permit bearing to expand radially without causing interference. Used on automatic screw machine produced by Cleveland Automatic Machine Co.

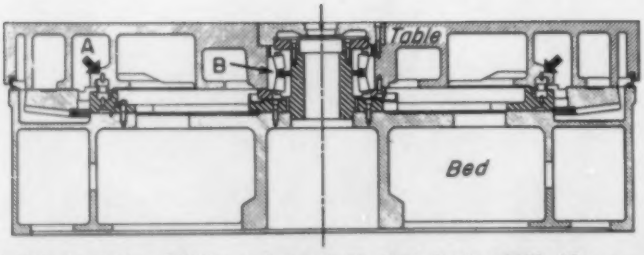
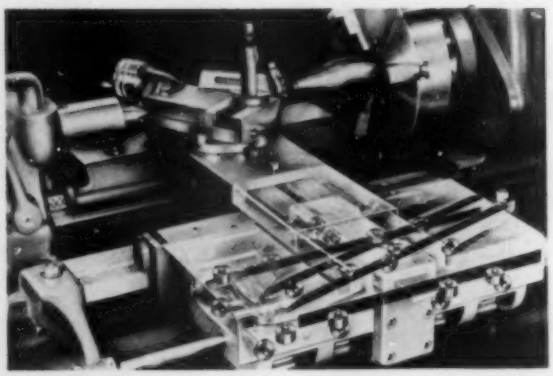
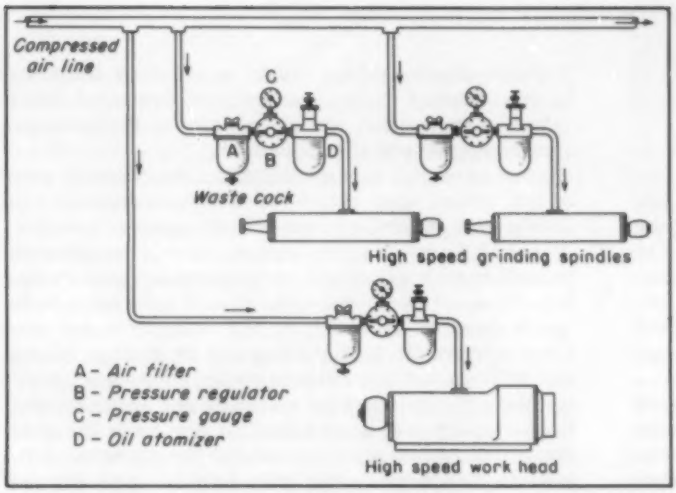


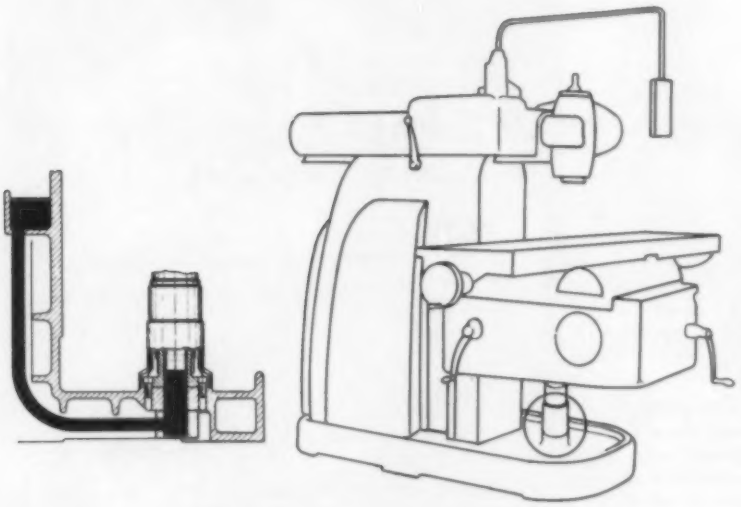
Table track for Giddings & Lewis Vertical Boring Mill rides on anti-friction bearing (A) consisting of upper and lower steel race with hardened rollers spaced in a bronze retainer. Entire assembly rolls in oil bath. Misalignment of table and work is prevented by large preloaded taper roller bearings (B). Preloading eliminates need for clamps and hold down devices to prevent tilting of table during cutting operations.

Monarch Series 61 lathes use anti-friction bearings exclusively on headstock, end gear train, gear box, apron, tailstock, and cross feed screw. Phantom view above shows number of ball bearings used in taper attachment alone. Dark areas represent flame hardened and ground bearing surfaces. →





Air-oil mist system used to lubricate high speed grinding spindles. Filtered dry air at about 15 psi is generally supplied by shop air systems. These systems are used primarily when speeds or ambient temperatures are such that conventional oiling methods would not provide adequate cooling.

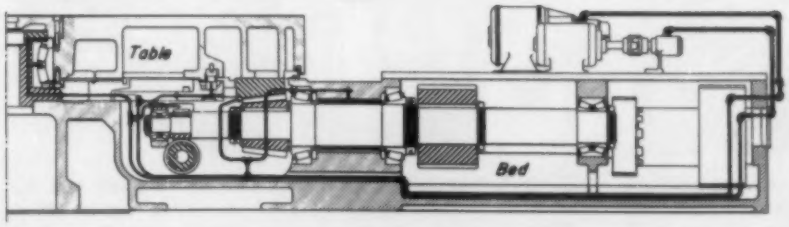


Vertical screws of Cincinnati Dial Type Milling Machines are lubricated automatically from an individual reservoir located in the column. Screw is continually bathed in oil as the knee traverses up and down.

Hypro Vertical Boring and Turning Mill, Giddings & Lewis Machine Tool Co., is a typical illustration of how two or more methods of lubrication may be used in one machine to satisfy different requirements. Motor driven pump on bed at rear of machine supplies pressure lubrication.

Main drive motor is interlocked with pump motor to prevent starting the machine without adequate lubrication to all table bearings.

Manually operated one-shot pumps conveniently located on ram, turret and side head provide adequate lubrication for all moving parts.



Lubrication

AN OVER-ALL LOOK AT lubrication equipment and techniques reveals the increased attention being devoted to this subject. On almost every machine there was some evidence of a careful analysis of friction and wear effect. Hit-and-miss hand oiling techniques have virtually been obsoleted. In their place are a wide variety of systems ranging from one-shot intermittent type lubricators that oil two or more bearing points, to completely automatic centralized lubrication systems operating continuously.

In most machines, two or more types of lubrication methods are incorporated to meet the different needs of various components. For example: the speed change and feed gears on a specific machine may be splash or pressure lubricated. On the same machine, the ways may be oiled by a one-shot lubricator, whereas rotating parts in the base may be continuously lubricated by an automatic metering system. Depending upon speed and load requirements, spindle bearings may be lubricated by a force-feed or an air-oil mist system, or the bearings may be packed with grease and sealed, requiring no additional lubricant.

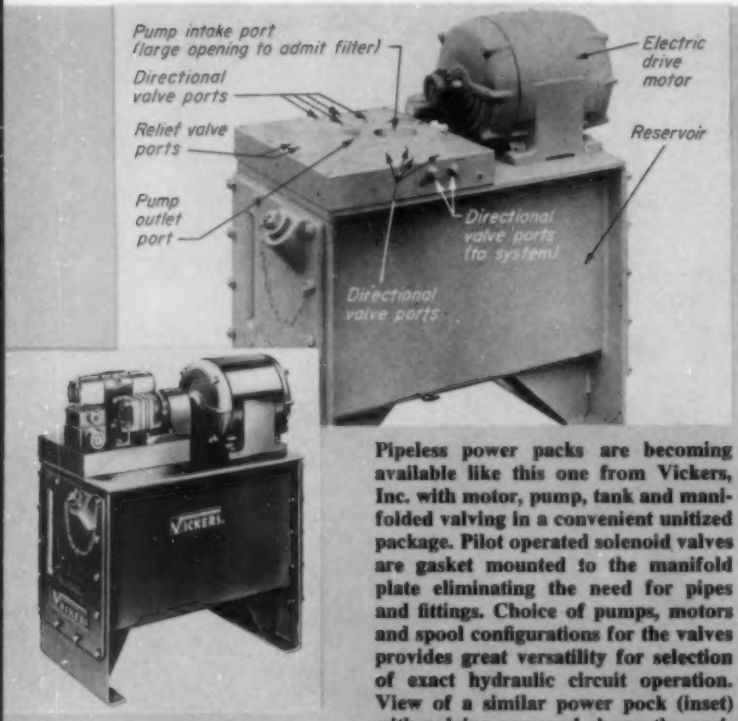
Many different arrangements were noted for insuring that a machine or component could not be operated without adequate lubrication. For example, in a horizontal boring machine manufactured by the Cincinnati Gilbert Machine Tool Co., a self-priming positive driven pump operates when the friction clutch is engaged. The slides on the Keller (Pratt & Whitney Div., Niles-Bement-Pond Co.,) type BG-22 milling machine, are automatically supplied with lubricant by a motor driven pump which operates continuously when the main switch is on. Many pressure lubrication systems were protected by safety switches. The main drive motor is interlocked with the pump motor so that it is impossible to start the machine without adequate lubrication. If, for any reason, oil pressure should drop below the safe operating level, the switches immediately stop all operation.

Hydraulics

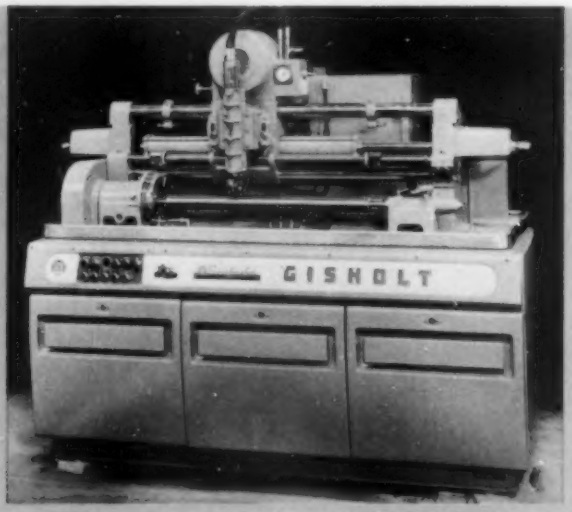
TAKING OVER THE FUNCTIONS OF GEARS, racks, levers and cam actuation, hydraulics is now playing an important role in the operation of machine tools. Piping and fittings are being replaced by manifold panels to which valves and pumps are flush mounted. Fluid flows in passages drilled through the panels. Structural members of the machine may also serve as manifolds when high pressure fluids are conducted through direct passages drilled in the parts.

Many other drawbacks to the use of hydraulics have been circumvented. Nonflammable fluids promise safer operation in hazardous applications. Teflon seals permit higher operating temperatures, though in high horsepower applications proper cooling of oil is still required. Variable delivery pumps reduce or eliminate throttling in flow control valves. Viscosity compensated relief valves insure a steady rate of operation of the hydraulic system regardless of oil temperature.

Even headstock and spindle drives, traditionally gear or belt driven, have been invaded by hydraulics for hydraulic gear shifting or hydraulically operated clutches. Warner & Swasey featured a headstock in which clutches provide sixteen speeds and reverse without gear changing. Their 1A lathe provides 32 unduplicated spindle speeds from 20 to 1497 rpm. The Bullard Co. has provided a hydraulic gear shifting unit on boring, milling and drilling machines. Pendent controlled solenoids actuate hydraulic cylinders for all speed and feed changes. Each cylinder rod is connected to a yoke in the gear box which shifts gears or clutches in geometric progression. Mechanical interlocks prevent cross engagement of feed or speed clutches.

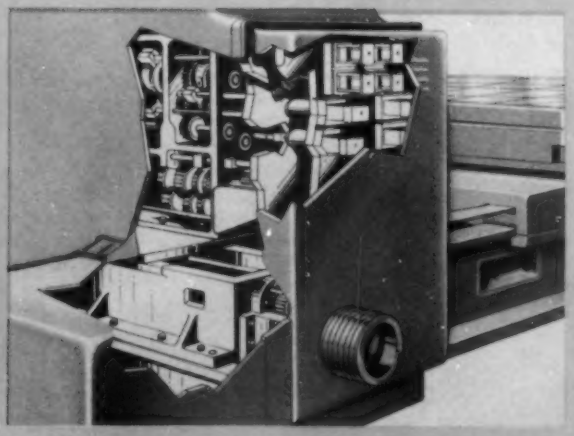


Pipeless power packs are becoming available like this one from Vickers, Inc. with motor, pump, tank and manifolded valving in a convenient unitized package. Pilot operated solenoid valves are gasket mounted to the manifold plate eliminating the need for pipes and fittings. Choice of pumps, motors and spool configurations for the valves provides great versatility for selection of exact hydraulic circuit operation. View of a similar power pock (inset) with valving removed shows the various access ports in the manifold.



Two hydraulic cylinders mounted back to back move the head on this Gisholt Superfinisher. The piston rods themselves are superfinished to 2½ to 3½ microinches to prevent oil seal problems in the cylinder packings.

To attach hydraulic hose to a moving carriage LeBlond designed a flexible strip of steel which guides a number of hose lines in controlled paths. Ears on either side of the strip contain bolts that hold the hose in place.



Electrohydraulic control is used for speeds, feeds and traverse in this Bullard headstock for vertical turret lathes. Hydraulic pistons move yokes in solenoid actuated sequence to shift gears and engage or disengage mechanical clutches.

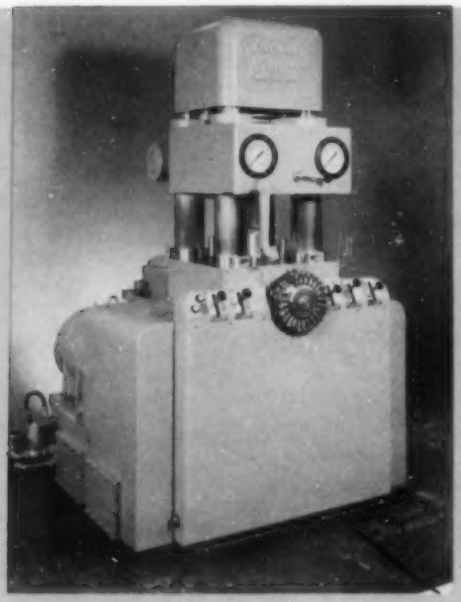
Grinder and planer tables are being driven by hydraulic cylinders in tandem arrangements. A large Gallmeyer and Livingston grinder incorporates two in-line cylinders arranged to move in opposition. Pressurized oil is supplied to both cylinders to affect table motion with both pistons pushing.

A similar arrangement on a planer by Rockford Machine Tool Co. takes advantage of three different net piston areas against which the high pressure oil is applied. Any one of three speed ranges may be selected by solenoid operated valves and a variable displacement pump is used to adjust the speed of traverse within each range. Top speed is 300 ft per min.

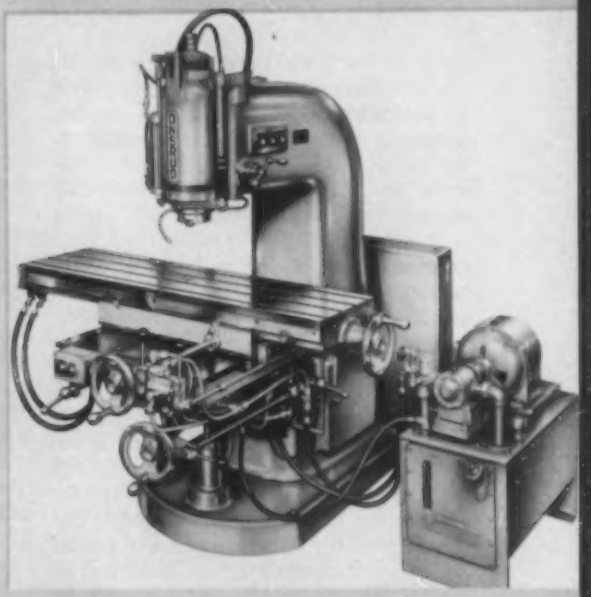
Standard general purpose milling machines whose tables have been moved by electric motor driven screws are now in several machines, powered with hydraulic motors. Flow control valves permit infinite adjustment of feed speeds and automatic cycling is possible with solenoid operated valves controlled by adjustable dog actuated switches.

For single purpose machines Ex-Cello Corp. is supplying standard quill-type hydraulic power units which will rotate and advance a tool. Rapid traverse and feed speeds are infinitely adjustable and settable dogs control stop, start and reversal of the quill. A self contained pump with associated valving provides high pressure oil for the tool advance cylinder. A valve for remote control start and return is available as extra equipment.

Installation convenience, versatility, and ease of centralized control have made hydraulic cylinders and motors standard equipment on much of the work handling and transfer equipment associated with automated machine tools. Carefully controlled advance speeds and overload protection provided by relief valves which limit maximum pressures provide the high power with safe control necessary to complex work handling problems.

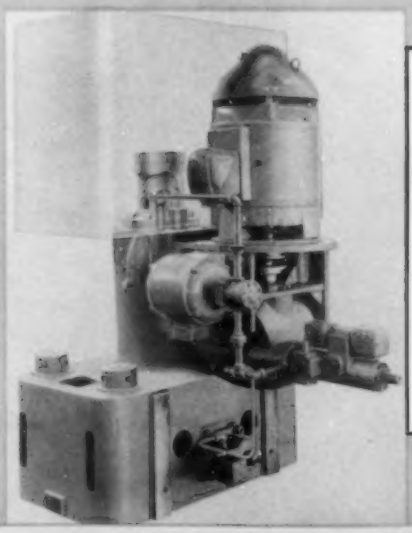


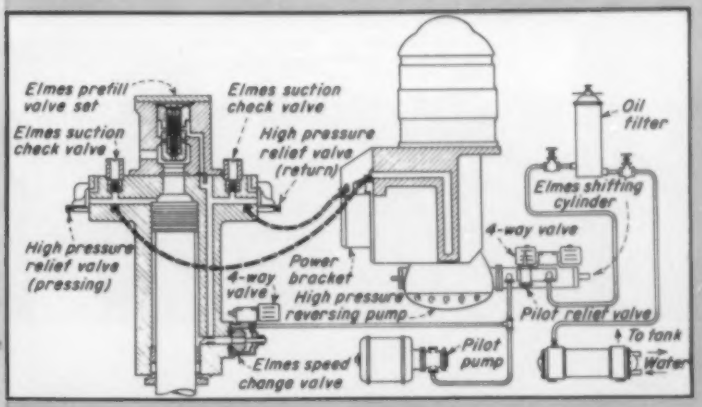
Sheet metal blanks up to 8 in. in dia may be drawn to a depth of 5 in. in this Cincinnati Milling Hydroform press. A male punch forms the inner surface of the draw and a flexible die member is backed up by hydraulic oil pressure which may be accurately controlled up to 15,000 psi.

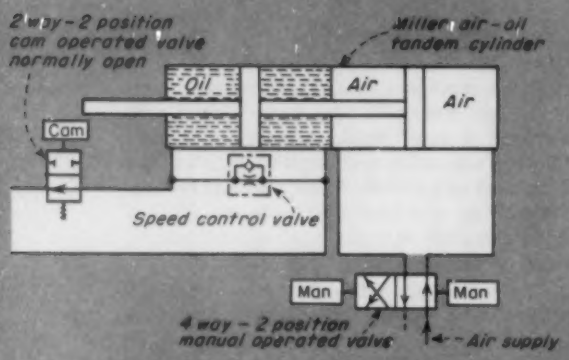


This Onsrud milling machine incorporates power feed in all directions by hydraulic motor drive of table screws. Speed control is in discrete intervals with five forward and reverse speeds for cross travel and vertical travel, four forward and reverse speeds in longitudinal travel.

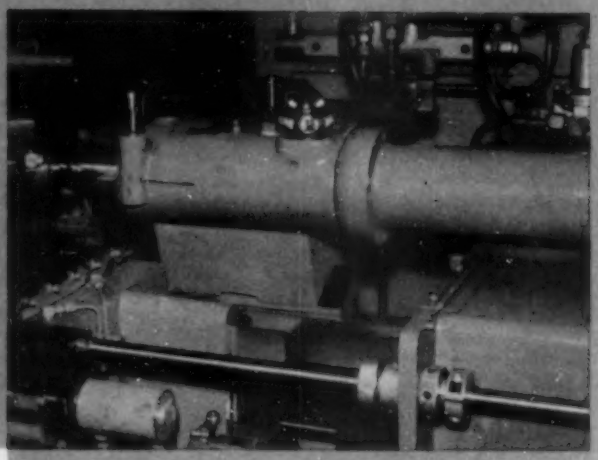
All high pressure flow in this Elmes pipeless press is conducted through drilled passages in the upper section (inset) of the press. The low pressure pilot circuit is conducted through standard tubes and fittings.



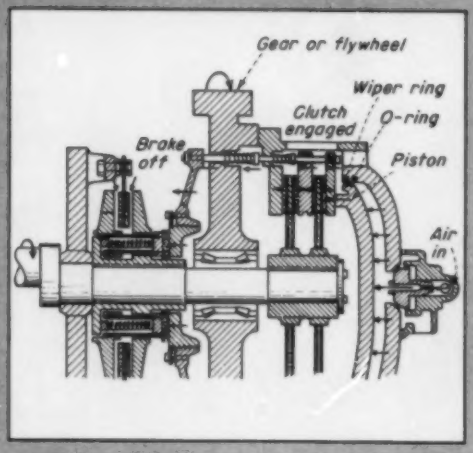




One simple method of achieving air power with oil metering is presented by this air-oil tandem cylinder by Miller Fluid Power Co. As is usual in these systems the oil is in a closed system requiring no tank.



Above, air operated tailstock on 12 x 18 Carbo Lathe, by Monarch Machine Tool Co. Below, air clutch made by Ferracute Machine Company applies air against large face of piston to provide disk loading against springs. Note that brake is automatically applied when clutch is disengaged.

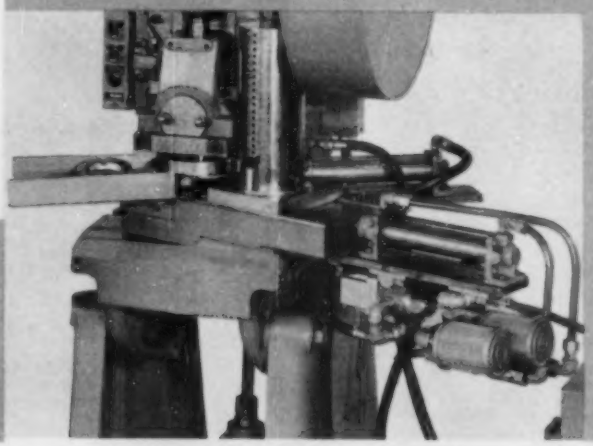


Pneumatics

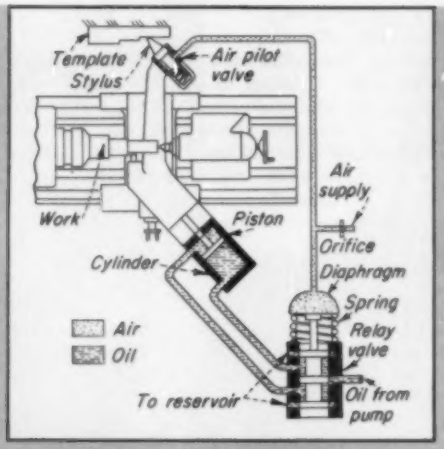
LIKE HYDRAULICS, pneumatics is playing an ever-increasing role in the operation of machine tool fixtures, stock feeders, tailstocks and slides. Several manufacturers of air gages were represented at the show and many exhibitors of automated transfer included automatic air gaging with subsequent part rejection and even compensated tool control. Several pneumatically operated tracing mechanisms are discussed in the section on Tracers.

The major advantage of pneumatically operated components is that air, under pressure, is readily available in the average machine shop without the need of extra motor driven pumps, tanks or return lines. Where carefully controlled feeds are desired, combined air-hydraulic systems are manufactured in which the air supplies the power source and piston motion is controlled by oil metering in several forms. Force multiplication is possible producing high forces without the need for large diameter air cylinders.

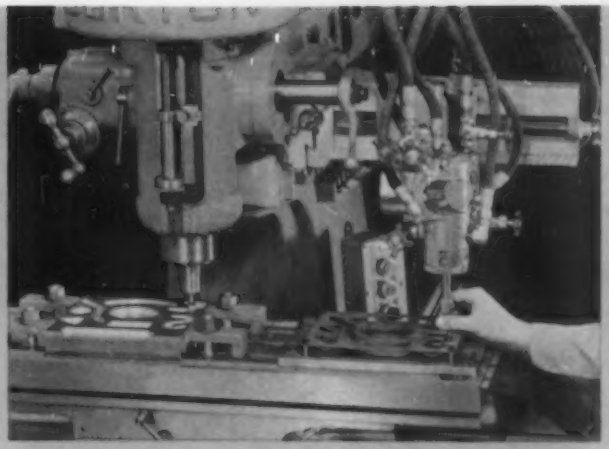
At least two rodless piston and cylinder combinations are used to feed bar stock into automatic machines. Many standard air cylinders position or kick out parts when the machining cycle is completed.



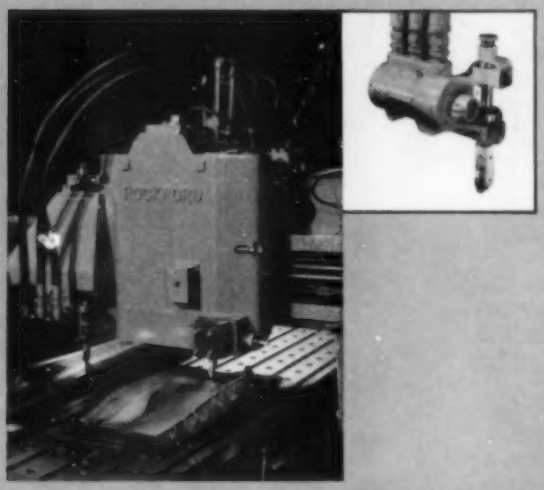
Air cylinders attached to this Famco press are used to load and kick out finished parts after the work cycle is completed.



Diagrammatic drawing of Monarch Air Gage Tracer showing how motion of the stylus of the air pilot valve controls spool position in the hydraulic relay valve. Flow through the relay valve determines position of hydraulic piston and tool.



Two or three dimensional hydraulic tracing is possible with this True-Trace Unit applied to a Gorton vertical mill. Three basic valve assemblies are controlled by a common stylus which coordinates the three spool movement to control the three directions of milling machine table movement. Needle valves permit closing of any one or two elements of the valve unit when contour or profile duplicating is performed.



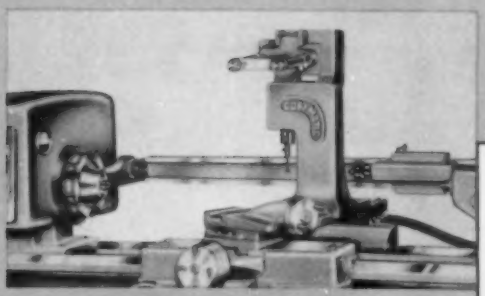
Single direction control is provided by this Rockford Machine Tool Kopy-Kat duplicator. The stylus operates a rotating valve (inset) to control flow to the vertical lift cylinder as the table carries both model and work past the tool head.

Tracers

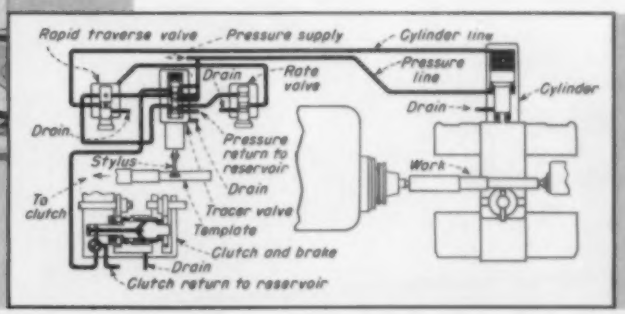
A WIDE VARIETY OF TRACING MECHANISMS were offered operating on many different functional principles. Lathes, milling machines and planers were controlled by air gage tracers, hydraulic valve tracers, optical, electrical and mechanical tracers.

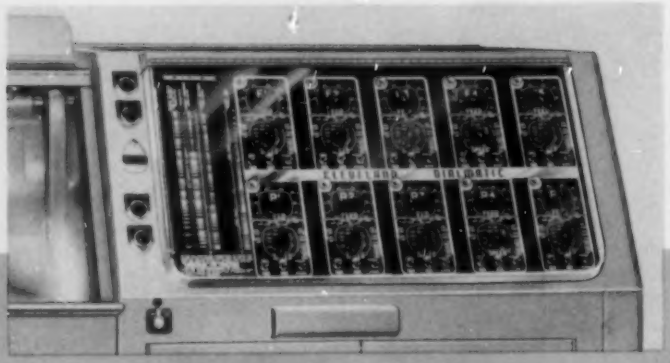
Air gage tracers follow templates with practically no pressure on the pickup. Most of the hydraulic valve operated tracers are similarly lightly loaded permitting the use of plastic or other soft material templates. Optical tracers will follow a line drawing or blueprint and are claimed to duplicate within a few thousandths of an inch.

Regardless of pickup, actuation of tool post or milling head is almost invariably affected by hydraulic power. Hydraulic valve tracers directly control flow to either side of a cylinder while air gages may actuate pilot operated valves and optical and electrical systems energize solenoid operated valves.



This Lodge & Shipley Copymatic attachment uses a hydraulic valve tracer which controls oil flow to clutch and brake as well as to the main actuating cylinder.





Enclosed panel controls speed and feed for as many as five operations on a Cleveland Automatic Machine Company screw machine. Once set, plastic panel may be closed and locked. External switches are for start and stop. Note panel feed calculation chart.

Controls

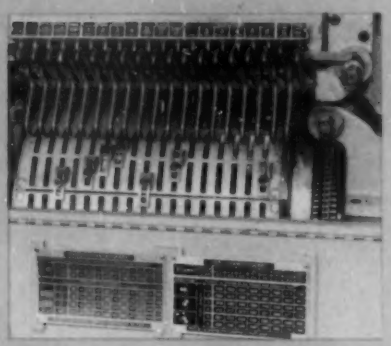
CONTROLS, IN MANY INSTANCES, have been grouped to provide for maximum operator convenience and safety. J.I.C. Standards used exclusively. All control systems use 110 v ac.

Usual procedure is to group the controls for any one function of the machine tool. For example, all controls, which include buttons or selector switches, for setup operations are grouped together. Speed and feed controls grouped. Some machines have dual interlocking speed and feed tools so operator may control from either front or side of work table.

Mechanical interlocks make it impossible, on almost all machine tools seen, to engage a wrong machine sequence. For example, it is impossible to engage the rapid traverse of a head while it is feeding, or change rate of feed until feed interlocking mechanism is in neutral, or change speed if spindle is rotating.

Many machines use signal lights to indicate the circuits that are closed. Where automatic gaging is included, signal lights indicate acceptance or rejection. Some machines have buttons which light and show control function name. All control buttons are plainly marked for identification.

Instruments showing hp, motor speed, spindle speed and other functions are used. Feeling appears to be that if the operator can read these speeds less machine tool and part damage will result. Many panels have nomograms or charts indicating best speed and feed for material or part being made.



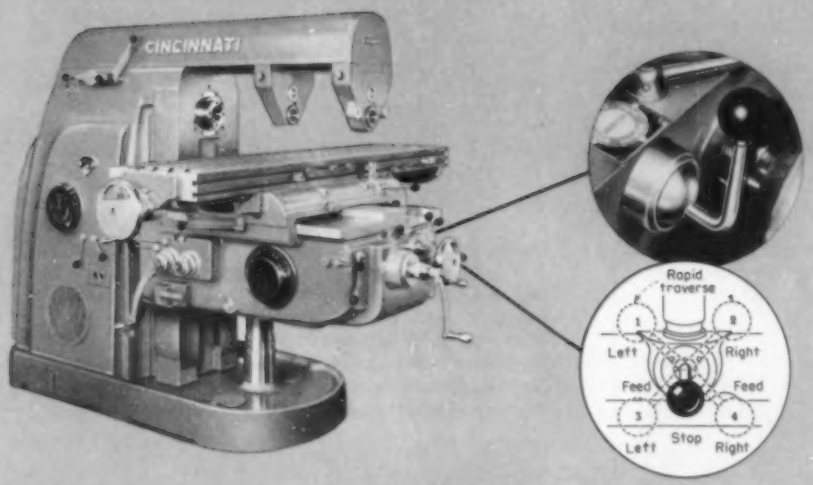
Drum which controls all machine functions such as automatic changes of feeds and speeds, rapid traverse and automatic stopping of the machine is used on the Potter & Johnston turret lathe.

Elecric pushbutton control for presses and cutting or forming equipment is typified by this Elmes unit. Both "close" buttons must be pushed to operate press. Red light is lit when oil temperature exceeds that for safe operation. Micrometer inching control permits control of slide movement for accurate setting and adjusting of dies.

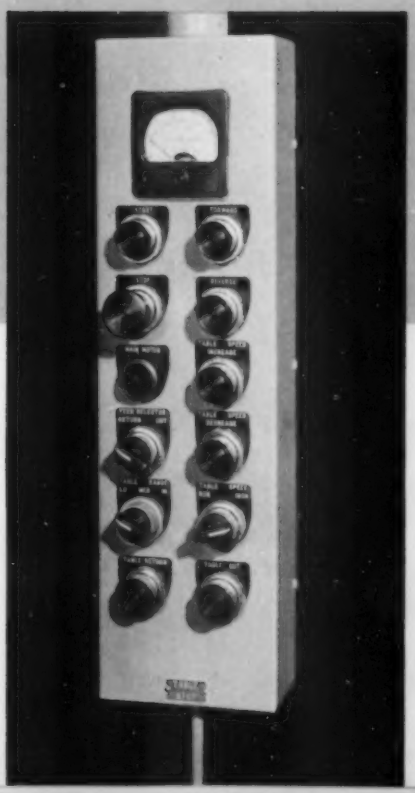
Panel on Monarch Tool Company Lathe. Dials set surface cutting speed and diameter to be turned. Note large mushroom-type stop button and horsepower indicator.

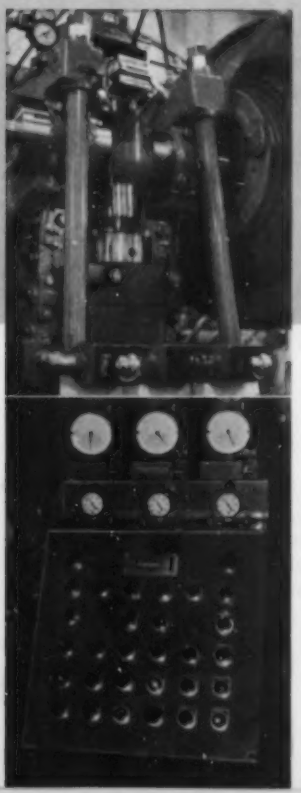
Electrographic detector system used to simplify the maintenance of complex electrical controls. System, designed by W. F. and John Barnes, isolates the trouble area by touching the test probe to contacts on the electrical diagram. A coded symbol indicates the exact location of the defect once the trouble area is found.

Pendant type control used on a Bullard Company machine. Pendant may be raised and lowered by power and will swivel through 270 deg. Directional controls are toggle type in X-slot. Raised and milled arrows indicate direction of motion.



Single lever operates power feed and speed changes on Cincinnati milling machines. Single lever control of table feed and rapid traverse is also incorporated. Feed and speed control is interlocked with rear operating controls.





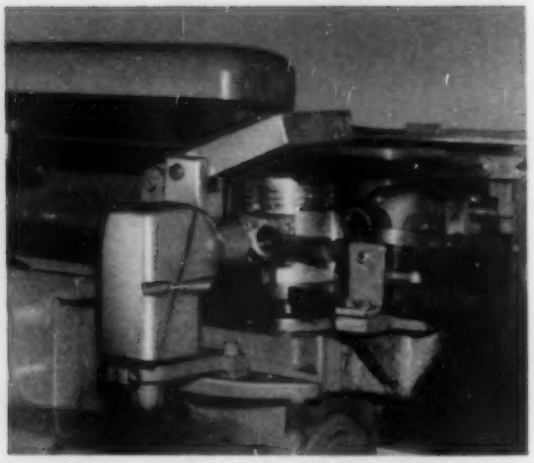
Some typical instruments provided for machine control or gaging. Monarch unit has rpm counter mounted on spindle cover. Walsh Press incorporates stroke counter. Note large mushroom start, stop and jog buttons. Gardner Company has part counter in panel as well as Sheffield air gaging set-up on double spindle disk grinder. Rockford Machine Tool pendant showing pushbutton controls, cutting speed meter and toggle type emergency stop hanging from bottom of pendant. Hitting toggle in any direction will stop machine.

Optical Systems

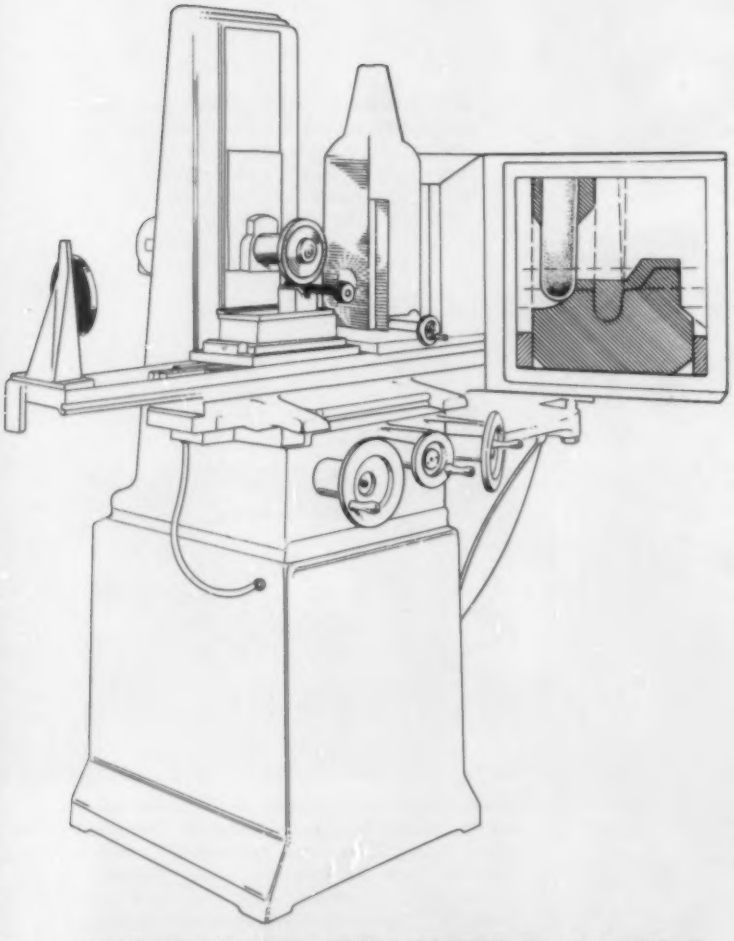
USE OF OPTICS as a machine tool aid is still severely limited. Notable is a system provided by Gray Planer Co. on their large horizontal boring mill through which longitudinal and vertical head position can be read from the operator's station without squinting or parallax error.

Profilometers alone or in combination with precision grinders provide large scale magnification on a screen permitting direct comparison of parts with drawings or layouts.

Transfer equipment may be signaled by breaking (or making) a light beam as parts move or turn in their travel. Counting or sequencing of operations is possible in this manner.

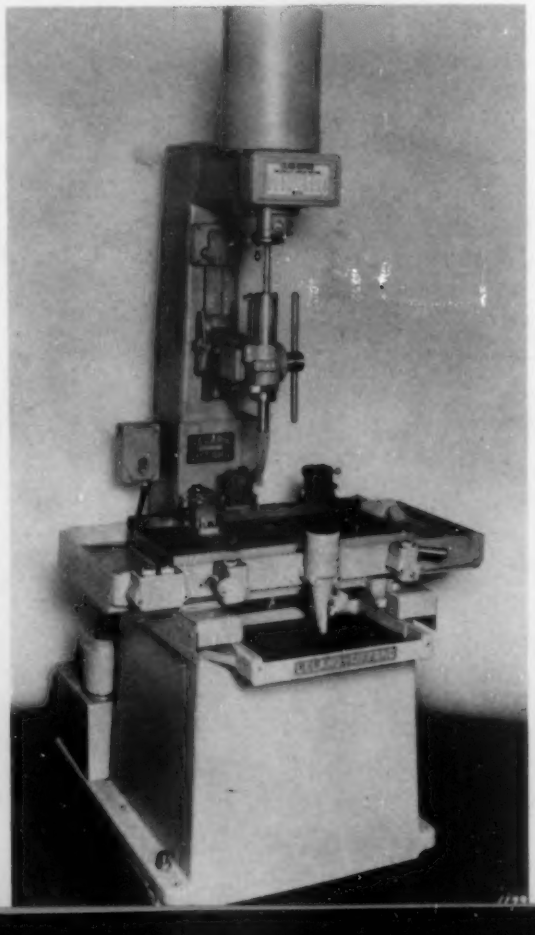


A different, and possibly significant, application of light sensitive cells to machine control was apparent in the Morris Machine Company's Automatic Piston Balancer. Pistons are fed to the rotatable table from the left. A lamp sends a beam of light at the piston, which rotates until the wrist pin holes line up, permitting the light to strike a photo-sensitive cell. Electrical controls then stop the rotation of the table and the piston is in correct position for subsequent operations of holding, boring to proper weight and checking.



Grinding machines are provided with profilometers in which an image of grinding wheel and work is projected on a large screen. Typical of these is the Visual Grind, of Cleveland Grinding Machine Co. Line drawings may be made on the ground glass screen and parts machined to match. Magnification ranges from 10:1 to 100:1 in six steps.

Designed for jigless drilling, a standard Leland Gifford drill unit has an oversize base on which a previously laid out template is mounted. An optical magnifier is mounted on the movable carriage and an enlarged image of the template is thrown up to a small screen. Crossed lines on the template are aligned with similar crossed lines on the screen by movement of the carriage, providing very accurate positioning for drilling.



Preventing Fires From Electrical Causes

Experience in design of electrical appliances suggests eight ways of reducing operating temperatures in any device requiring a motor, resistance heater or other electrical source of heat.

H. A. STRICKLAND, JR.
Vice President, Engineering, Hotpoint Co., Chicago, Ill.

MANY DOMESTIC APPLIANCES today contain relatively complicated mechanisms and controls which have operating duty cycles formerly used only in industrial equipment. Safety from operating hazards, particularly fire, is required because these devices use relatively large quantities of electrical power, are operated by untrained personnel, and are often unattended for lengthy periods of operation. While the design techniques described here have been developed out of experience in satisfying Underwriters' Laboratories requirements for major domestic appliances, they are equally applicable to the design of industrial appliances and equipment.

Electrical fires are started by heat from an electrical source. Motor-winding burnouts is the largest specific cause; defects in wiring and cables is second; unattended heated appliances or lamps in contact with or too close to combustible material is third, while fires originating from electrical cords is fourth.

Fire prevention consists of controlling elevated temperatures associated with (1) normal operation, and (2) abnormal operation of the device, such as misuse, part failure, or defective installations. Control of normal operating temperatures is best accomplished on a "cut and try" basis in an actual prototype. Control of abnormal temperatures is obtained by preventive measures including sound structural design; adequate electrical and thermal insulation; proper electrical protective devices; containment of fire and molten metals or water liable to start a fire; and effective installation, operation, and service instructions. These instructions serve to prevent fires which are beyond the designer's control.

Control of Temperature in Normal Operation

Varying the size of electrical heat source would seem to be the first step in normal temperature control. If temperatures are too high a heating unit of smaller rating, or a larger motor, solenoid, or control can be used; however, heating-element wattage are normally set by required performance levels and larger motors or control components are more expensive. For both performance and economic reasons it is therefore usually preferable to devise other methods of improving heat dissipating to obtain cooler hot spots or reduce heat flow causing excessive operating temperatures.

Convection cooling is the principal method for dissipating normal heat flow. In addition to the air currents which flow over the external surfaces, chimney effects can be used to provide internal cooling, as shown in the three examples in Fig. 1. In (A) air enters the toe space of an electrical range, flows under and through the range and up and out the top of the backsplasher, thereby cooling the internal parts and controls. Hot spots not cooled sufficiently by general convection can sometimes be cooled by means of a draft stack or duct which serves to increase velocity of air flow and concentrate the coolest available air directly on the trouble spot. In the example shown in (B) the hot-spot temperature of the timer control was reduced 20 F below that obtained with only general convection cooling.

Forced air cooling is very effective. Fig. 1 (C) shows the location of an added fan on a disposer motor which lowered operating temperatures 50 C over the equivalent performance without it.

Radiation cooling utilizing the high emissivity of porcelain enamel is frequently an aid to reducing temperatures.

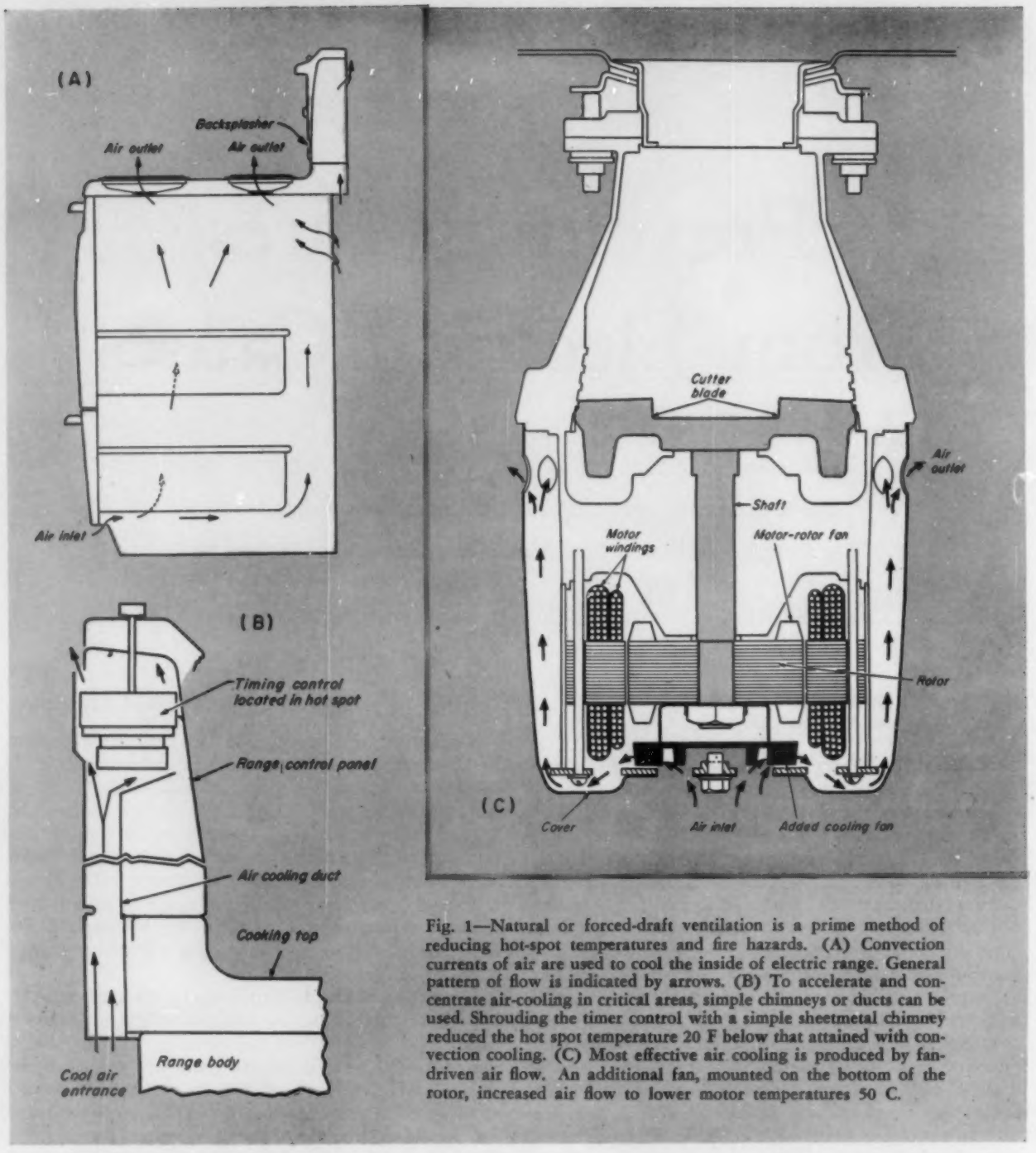


Fig. 1—Natural or forced-draft ventilation is a prime method of reducing hot-spot temperatures and fire hazards. (A) Convection currents of air are used to cool the inside of electric range. General pattern of flow is indicated by arrows. (B) To accelerate and concentrate air-cooling in critical areas, simple chimneys or ducts can be used. Shrouding the timer control with a simple sheetmetal chimney reduced the hot spot temperature 20 F below that attained with convection cooling. (C) Most effective air cooling is produced by fan-driven air flow. An additional fan, mounted on the bottom of the rotor, increased air flow to lower motor temperatures 50 C.

Hot gas deflectors which divert hot air away from temperature-sensitive areas are occasionally useful. The custom built-in oven popular today is frequently installed flush in combustible walls. A small deflector at the top is used to guide the rising stream of hot air away from the wall above the oven. For long periods of operation this is not adequate, and a larger pull-out deflector which projects further into the room deflects the hot gases a greater distance from the walls.

Reduction in heat-flow rates prevents heat flow from higher-temperature areas to areas with a lower maximum-temperature tolerance. Techniques for heat-flow reduction include spacing, insulation, and reflection.

Increasing the space between a heated object and a critical temperature area is a simple and effective means of reducing temperatures. A griddle designed for use on a porcelain surface overheated a plastic surface under the griddle. Raising the griddle by adding $\frac{1}{8}$ in. to the griddle supports decreased the temperature of the plastic surface enough to permit safe use.

Thermal insulation, usually of an inorganic type, is used to limit heat flow where cooling is inadequate. An application example is in the range oven where the insulation is not limited by the economics of oven operation but by

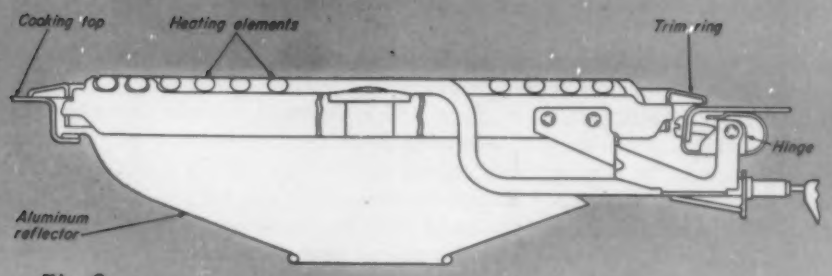
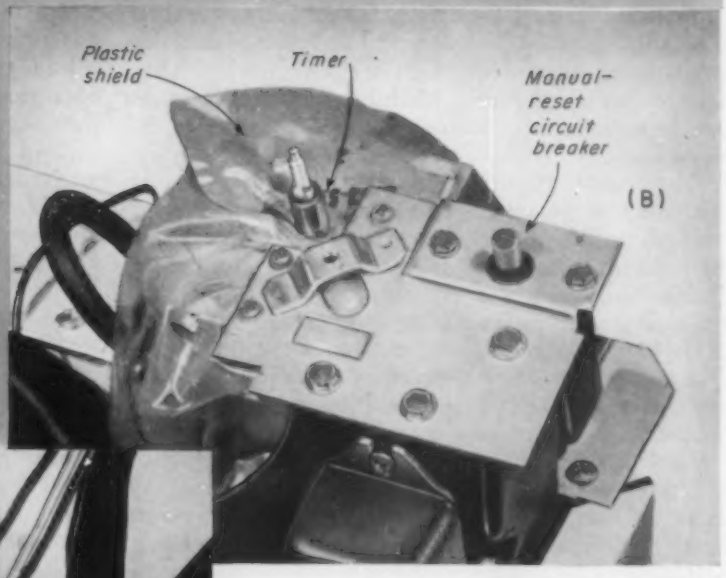
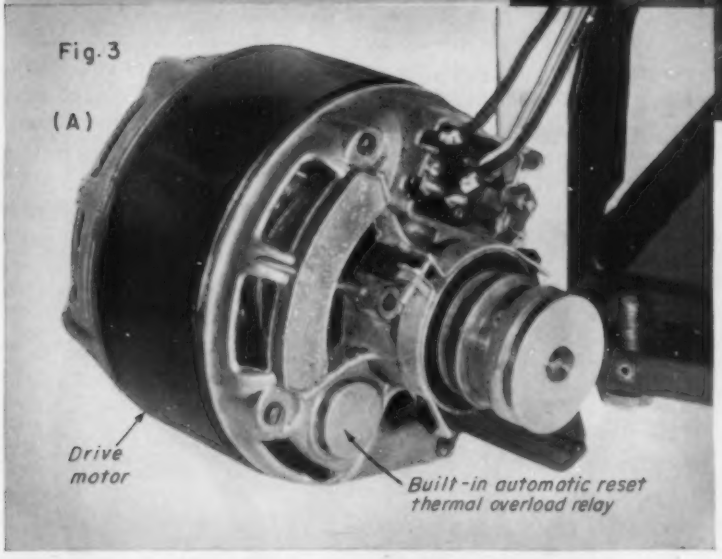


Fig. 2

Fig. 2—Maximum use of reflecting qualities can reduce undesired temperatures at rear of reflector, particularly when used with high-temperature elements. Changing this heating-unit reflector from porcelain-enamel steel to aluminum lowered temperatures below unit by 30 F.

Fig. 3—Motor burnouts are a principal cause of fires, and over-current or thermal protection must be provided to prevent this. At right is an example of a manual-reset circuit breaker located alongside the timer of a washing machine. On an overload the breaker must be reset by hand before the appliance is again operative. View at left shows a thermal-overload relay which is an integral part of the motor driving a different type washer. When thermal relay operates on overload, motor will not operate until relay has cooled to the temperature determined by the characteristics of the thermal unit.





Abnormal Temperature Control

Temperatures from abnormal operation of the appliance are more difficult to participate and control. Such abnormal conditions include misuse, parts failure, and defective installation. The October 1953 report of the International Assoc. of Electrical Inspectors states that most electrical fires are due to misuse; in addition, the report calls attention to a 500 per cent increase over the previous year in fires caused by defective installations.

Motor overloads most commonly produce abnormal elevated temperatures. Overcurrent or overtemperature devices shown in Fig. 3 are generally used for protection against these overloads. The automatic-reset type is generally used where no operator hazard exists should the device automatically restart. Refrigerators, freezers, automatic washers and clothes dryers with door interlocks and similar types of equipment are so classified. Automatic washers and continuous-feed disposers without access-door interlocks utilize manual-reset overload devices to avoid a casualty hazard.

In clothes dryers, fixed overtemperature thermostats are used, in addition to adjustable thermostats, to doubly insure against internal fires. This extra precaution is taken because of the combustible material present in these dryers

the maximum temperatures on the outer surfaces of a range. Underwriters' Form O installation permits the range to be installed in direct contact with combustible materials so that temperature control of surfaces adjacent to the oven is a function of the insulation.

Radiant heat reflectors can be used to control normal temperatures. They are usually most effective when higher temperatures are involved. An example, shown in Fig. 2, is the use of an aluminum reflector pan under the surface heating unit of an electric range. Temperatures below the reflector were reduced 30 F when an aluminum pan was substituted for one with a porcelain-enamel finish.

and to protect against such contengencies as loose drive pulleys or belt failure which would produce a hazard.

Operating carelessness can cause fire, and design features must protect equipment against this. As an example, in an immersion type fryer shown in Figure 4, both heating unit unit and thermostat bulb are immersed in fat. If the unit is turned on with barely enough fat to touch the heating element, the immersion-thermostat response is inadequate to prevent a fire. By adding metal thermal bridges between the unit and the thermostat, enough heat is conducted to the thermostat to cut off the heating unit before dangerous temperatures can be reached.

Electrical or mechanical parts failure, loss of electrical clearances, or flooding with water or other conducting solutions can cause short circuits or electric arcs which can lead to fires in appliances. Mechanical design precautions which minimize these hazards are an important aid to the designer.

The cabinet, frame, and all components mounted on the frame of the appliance or equipment must have the strength and rigidity to withstand all abuses to which they might be subjected to in production, distribution, installation, service, and use. Wide variety of equipment sizes, shapes, and methods of assembly eliminate the possibility of establishing specific metal-thickness limitations. The strength must be sufficient to prevent partial or total collapse which might reduce electrical spacings, damage insulation, or loosen and displace functioning parts.

Cabinet and frame strength is obtained by the use of weldments rather than fasteners wherever possible; by securely mounting electrical components, using a means other than friction, so they are prevented from turning or shifting; and by effective use of anticorrosion finishes for all metallic components. Whenever possible, cabinets should completely enclose the appliance to confine any combustion which might occur.

Internal wiring and connections should be protected by shields, enclosures, wireways, and armored cable against exposure to oil, grease, moisture, and mechanical injury. Wireways should be free of sharp edges and burrs which could damage insulation. Spacings between terminals have been established by industry and by UL. On motor terminals boards ½ in. between terminals of opposite polarity, ¼ in. to ground through air, or ⅜ in. to ground across a surface is considered satisfactory for voltages up to 250. When the design and assembly limit possible movement of the parts, somewhat smaller spacings and clearances may be safe.

Specifications for wire should take into account the temperature and voltage, to which it may be subjected, and also possible exposure to oil, grease, moisture, or other substances which may affect its life. All splices and connections should be mechanically secure, and insulation should be at least equal to that on conductors. Leads to motors or other components should be surely tied or fastened by other means so they cannot be caught in the rotating parts of the motor or mechanism it drives, with consequent grounds, arcing and fire.

Electrical supply connections must be given major attention. Strain relief of the external cord should be provided to protect connections and internal wiring. Where damage could occur if the line cord were allowed to feed back into the cabinet, this should be prevented by a suitable stop. Sheet metal, to which the conduit of the supply connection is normally attached, should be stiffened to prevent excess vibration which could result in loose connections, frayed insulation, and arcing.

Insulation of electrical current-carrying components, when required, should be made with porcelain or phenolic parts of the proper rigidity, strength, and resistance to ambient conditions sufficient to withstand maximum mechanical and electrical stresses of normal use.

Where the failure of water-bearing parts would flood electrical circuits or components, deflectors should be used to safely drain the water away. Fig. 5 (A) shows the location of a pan in an automatic clothes washer which diverts water from electrical parts if the flexible-rubber sealing boot above it fails. To protect molten metals or burning insulation of failed electrical components from reaching combustible materials within and adjacent to the appliance, special pans or baffles, as shown under the dishwasher in (B), should be included.

Warnings to the ultimate user should be prominently and permanently displayed on the appliance or equipment when safety against a fire hazard cannot be designed into the device. For example, clothes dryers have instructions

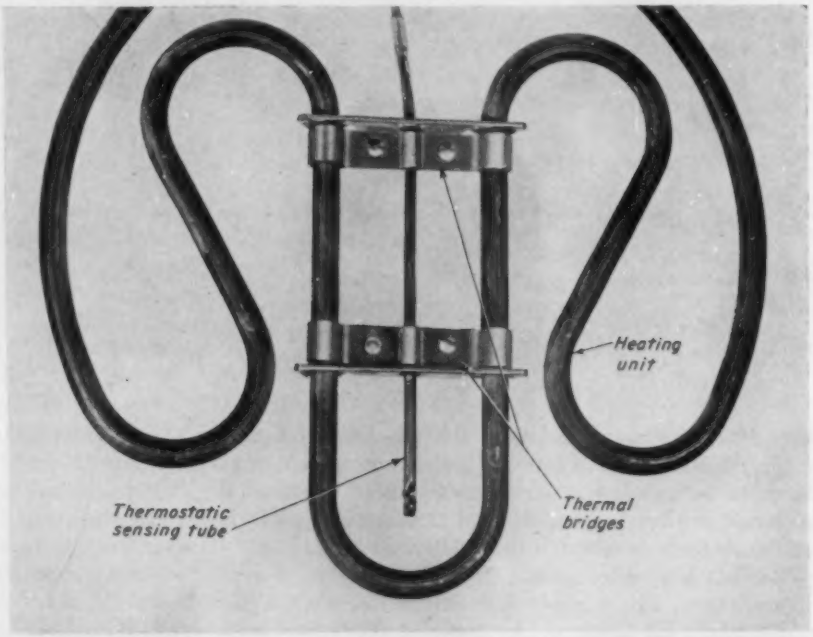


Fig. 4—Protection from user carelessness must be designed into equipment. An example is the addition of thermal bridges on this immersion fat fryer which conduct enough heat from the heating unit to the thermostat to maintain a safe heating-element temperature in shallow fat levels and yet prevent the heating element from exceeding a safe temperature in shallow fat levels.

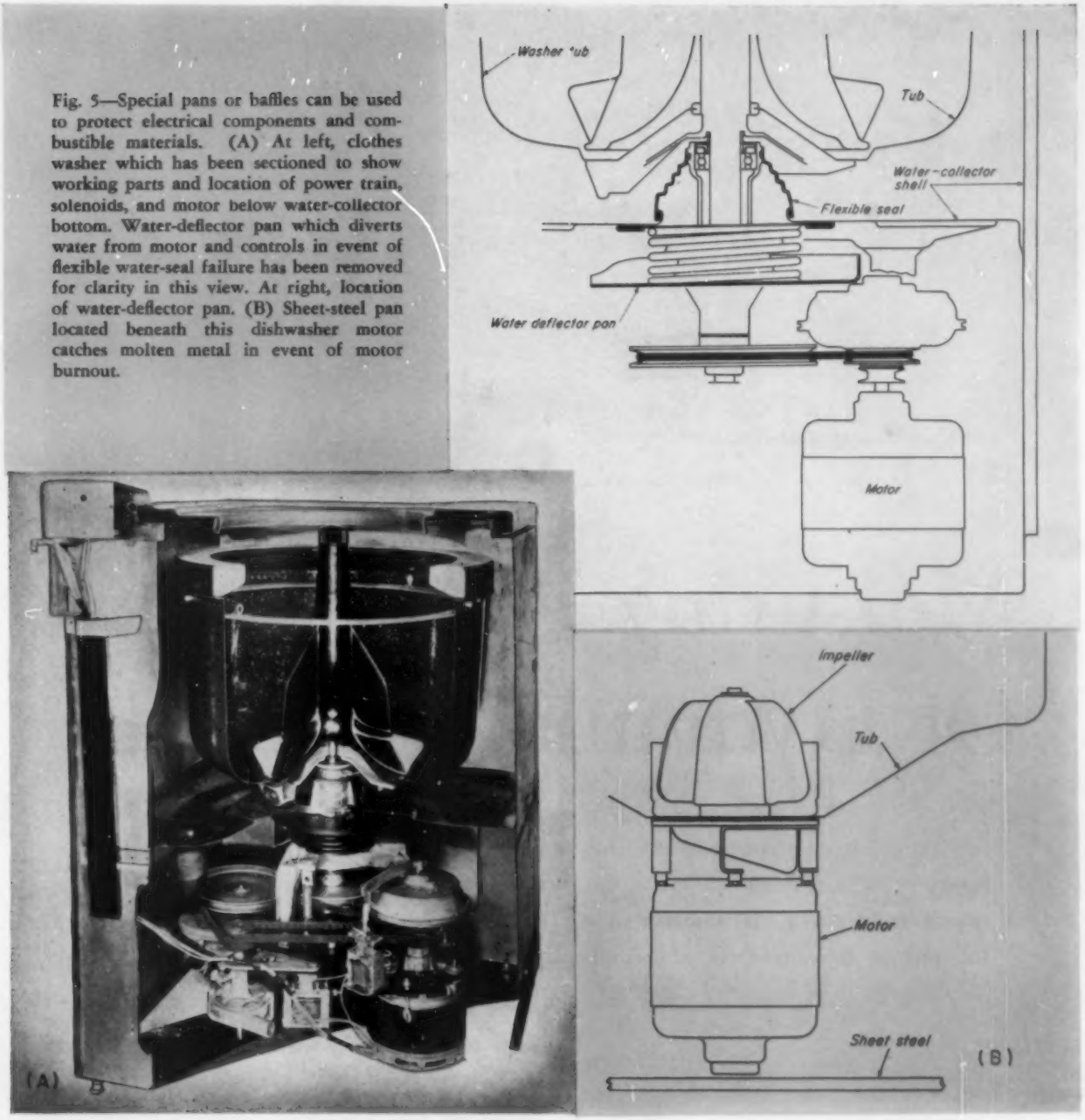


Fig. 5—Special pans or baffles can be used to protect electrical components and combustible materials. (A) At left, clothes washer which has been sectioned to show working parts and location of power train, solenoids, and motor below water-collector bottom. Water-deflector pan which diverts water from motor and controls in event of flexible water-seal failure has been removed for clarity in this view. At right, location of water-deflector pan. (B) Sheet-steel pan located beneath this dishwasher motor catches molten metal in event of motor burnout.

permanently fused into the procelain enamel of the dryer door to the effect that it should be used for drying water-cleaned fabrics only; this is to forestall do-it-yourself dry-cleaning experts from using the machine for that purpose. Where the appliance may be moved and connected to the electrical supply by the user, detailed cautions regarding connection to the power source are also attached. Further warnings against improper use and care are included in the customer's instruction books.

Since faulty installations are one of the major causes of electrical fires, it is important that the installation and service instructions produced for the field service organization place sufficient emphasis upon these and other hazards and plainly indicate the proper means to avoid them, or at least to minimize them.

ADDITIONAL DATA AND INFORMATION useful in designing to reduce electrical fire hazards are contained in these previous articles: "Protective Coatings for Electrical Contacts," April 1955 page 156, describes the use of various type coatings to prevent or inhibit the formation of relatively high-resistance surface films on copper and aluminum conductors and connectors; these high-resistance films can be the source of overheating and actual contact-surface disintegration and arcing. "Motor Overload Relays," January 1955 page 177, presents the fundamentals of operation and application of bimetal thermal overload relays for normal and unusual service; how to determine and coordinate tripping time with short-circuit protection is also included. "Controlling Radiant Heat," October 1954 page 175, describes how desired reflection and radiation characteristics of various common metals and nonmetals can be effectively influenced by the choice of surface finish; several of the applications described are electrical appliances; an extensive bibliography is also included.

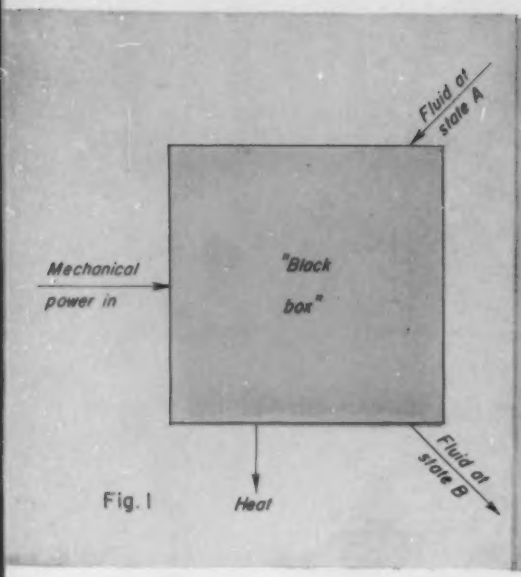


Fig. 1

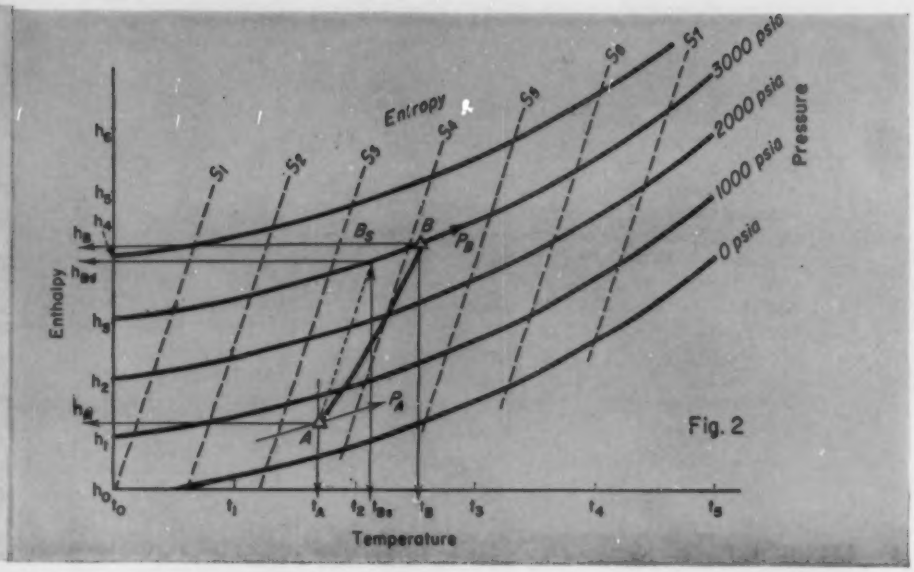


Fig. 2

Measuring Performance Of Hydraulic Machines

Input and output power and efficiency can be determined from temperature and pressure measurements of the hydraulic fluid, replacing torque meters when speeds are high or shafts inaccessible. Thermocouple and thermistor methods for precise measurements of rapidly changing temperatures are compared.

H. STERN

Aeronautic and Ordnance Systems Div. General Electric Co., Schenectady, N. Y.

HYDRAULIC PUMPS AND MOTORS of recent years have outgrown their test facilities. Dynamometer or torque shaft installations for testing pumps of 5 to 20 hp and 9000 to 15,000 rpm present no satisfactory solution to the test requirements. In one instance a welding generator set was brought into the laboratory to drive a cradle-mounted d-c motor at 11,000 rpm. Other test-stands were not as spectacular but equally cumbersome. At such speeds each new test requires special power measuring equipment.

Thermodynamics has helped the turbine engineer in similar problems for many years. The principle of thermal power measurements is simply the equivalence of mechanical and heat energy. A pump is a power converter, just like a turbine, an electric motor, or a compressor. It can be considered a generalized "black box" which trades one type of energy for another.

The problem now is how to measure the passage of energy into and out of the "black box" without using torque or speed. Since the hydraulic fluid carries energy away from a pump, the energy change in the fluid passing through the "black box" can be measured. This is a problem in thermodynamics.

The energy level or enthalpy of any fluid can be determined from its temperature and pressure. This determination requires a knowledge of three independent physical constants of that fluid such as the Joule-Thomson coefficient, $\partial t/\partial p$, (h = constant), the specific heat at constant pressure c_p, and the specific volume v, or the compressibility $\partial v/\partial p$, (t = constant), the coefficient of expansion $\partial v/\partial t$, (p = constant) and the specific heat. From such quantities and the Maxwell relations, the enthalpy and entropy values may be calculated for a given fluid and enthalpy-temperature charts constructed. One such computation procedure is described below in greater detail. The diagram of Fig. 1 and the chart Fig. 2 then explain the process of determining power and efficiency. Fluid enters at a pressure p_A and temperature t_A and leaves at a pressure p_B and temperature t_B. The total energy supplied

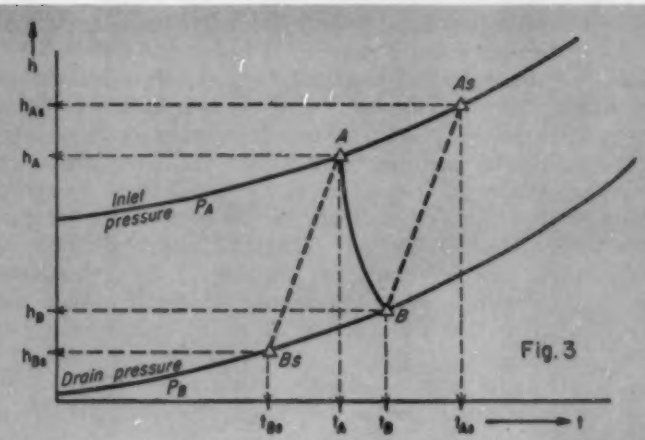


Fig. 1—Hydraulic fluid when suitably charted, acts as its own dynamometer. Temperature and pressure measurements of the fluid permit determination of energy level (enthalpy) into and out of "black box" as work is done on or by the fluid. Fig. 2 diagrams compression curve of fluid which enters pump at state *A* and leaves at state *B*. If the pump were ideal, compression would occur along the isentropic line *A*-B_s. Fig. 3 diagrams expansion curve of fluid which enters hydraulic motor at state *A* and leaves at state *B*. Constant pressure lines are so closely parallel on *h-t* diagram of liquid that the ideal work (h_A-h_{Bs}) is approximately the same as (h_{As}-h_B).

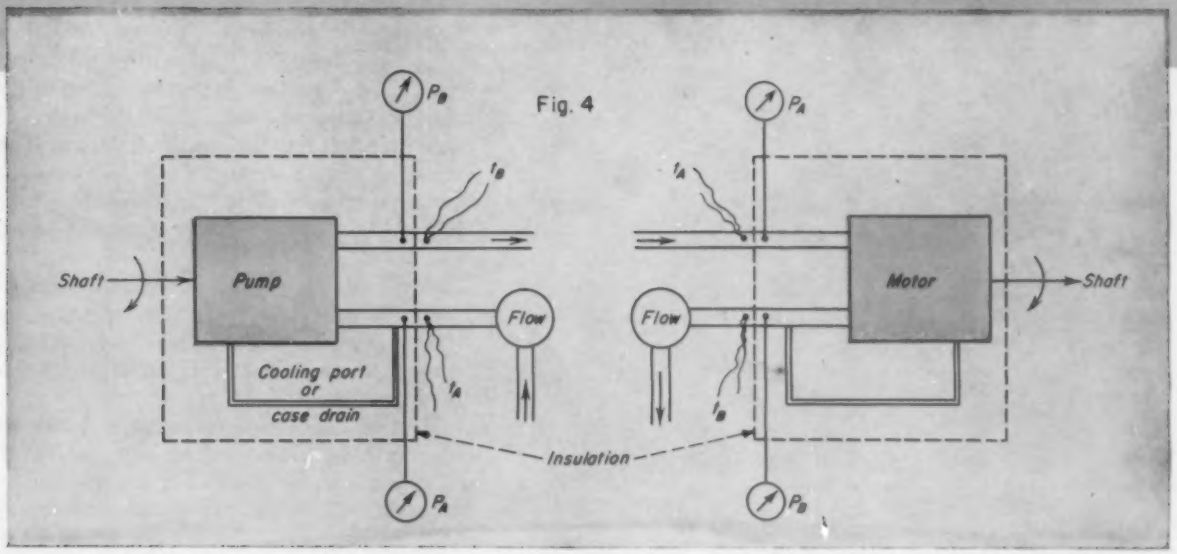


Fig. 4—Simplest form of pump and motor schematics in which cooling port or drainage oil flow is returned to reservoir line before thermodynamic measurement of pressure, flow and temperature. Insulation may be required where heat loss to surroundings is an appreciable percentage of total energy exchanged.

to the pump in the form of work and heat will be ($h_B - h_A$) *BTU*/lb of fluid passing. In order to make first computations more meaningful, assume the "black box" is insulated and $q = 0$. Then the mechanical power supplied is

$$(h_B - h_A)\frac{\text{BTU}}{\text{lb}} \times w\left(\frac{\text{lb}}{\text{sec}} \times \frac{\text{hp sec}}{0.707\ \text{BTU}}\right)$$

Had the work been done on the fluid without losses in an ideal pump the compression would have taken place along a constant entropy line and ended at B_s. Since the efficiency η of the pump is defined as the ratio of ideal to actual work

$$\eta = \frac{h_{Bs} - h_A}{h_B - h_A}$$

and is independent of the flow. The available power, frequently written as *Flow* × *Pressure/constant* is ($h_{Bs} - h_A$) BTU/lb of fluid. Lines of constant pressure and constant entropy are so nearly parallel for liquids that ($h_{Bs} - h_{As}$) is equal to the ideal available pump output (or motor input) power. In this simplest example, the pump received and discharged equal mass flows, and received power without loss of heat through the case.

In a hydraulic motor the same computations apply, as shown in Fig. 3, except that ($h_B - h_A$) would be a negative number showing that work was obtained from the expansion process. The ideal work obtainable from the fluid at state A, ($h_{Bs} - h_A$), would be greater than ($h_B - h_A$), and the motor has an efficiency of

$$\eta = \frac{h_B - h_A)}{(h_{Bs} - h_A)}$$

where $\eta < 1.0$. In both the foregoing examples, any cooling port flow, case leakage, or drain port flow is assumed to be piped back into the main fluid circuit for simplicity of treatment. Fig. 4 shows the arrangement of the physical components.

When the simplified cooling port drain connection shown in Fig. 4 cannot be used it becomes necessary to measure flow, temperature and pressure from the cooling port as well as from the main line, as shown in Fig. 6.

The enthalpy-temperature diagram for this flow schematic is shown in Fig. 5. Here w_A lb of fluid enter at port A and split up into the flow to B ($w_B = w_A - w_C$) and cooling port flow w_C. Since the cooling port flow w_C is not useful working fluid, the output power is written as $(h_B - h_A)w_B$ BTU/sec. The input power is $(h_B - h_A)w_B + (h_C - h_A)w_C$ BTU/sec.

The problem of insulation in the foregoing cases is not a serious one in most of our present day high pressure hydraulic machines. In a 3000 or 5000 psi aircraft hydraulic pump delivering 12 gpm or more, thermal losses to the surroundings are very small compared with the power handled by the machine. A dual layer of aluminum foil with a 1 in. thickness of any standard insulation material such as spun glass or rockwool will effectively prevent radiation and convection losses to the surroundings. If the unit is flange mounted, a gasket of 0.030 to 0.050 in. asbestos or felt paper will help to reduce conduction losses to the colder mounting bracket. If the pump is to be tested at oil temperatures near its environmental temperature none of these precautions are needed since heat losses are a function of the temperature difference between the working fluid and the surrounding air and structures. Insulation is intended only as a means of raising the temperature of the immediate environment of the pump to the temperature of the oil inside the pump so that no heat can center or escape from the "black box."

If no means are available to insulate the unit and heat losses are suspected to be of appreciable magnitude, a rough estimate of these losses is frequently adequate. Relatively large errors in this calculated heat loss (say ±25 or 30 per cent) still would be tolerable because the total heat loss is very likely only ½ or 1 per cent of the power input. The accompanying example serves for ready reference and will show the order of magnitude of the various heat losses. The derivation of the equations can be found in "Heat Transmission," by McAdams, McGraw-Hill, 1942, or any standard engineering handbook.

Total heat loss in this example is equal to 300 BTU/hr or 0.12 hp. It is evident that by insulating, both the convection and radiation losses approach zero and the heat loss is reduced to 0.04 hp.

Effect of heat loss in a pump is shown in Fig. 7. The heat loss $q = (h_B - h_{Bo})w$ *BTU*/sec appears in the form of a lowered outlet temperature t_{Bo} in this pump. The theoretical outlet temperature t_B should have been higher by an amount computed from the above equation. Input power is as before $(h_B - h_A)w$ *BTU*/sec.

Chart Construction

Computations to determine the thermal properties of the fluid follow the standard procedure used in thermodynamics of gases. *A*

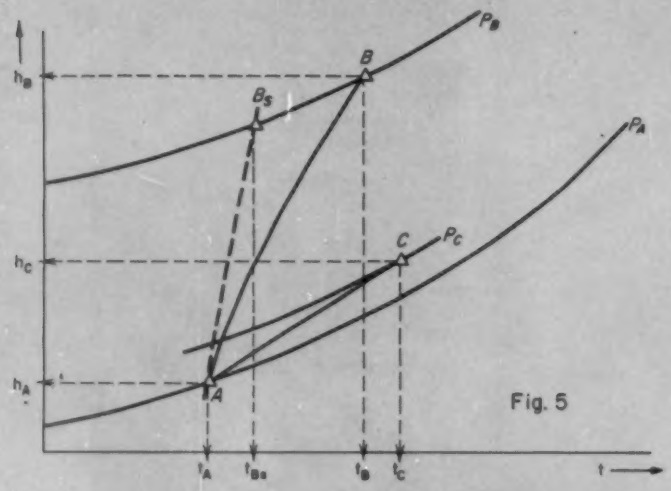


Fig. 5

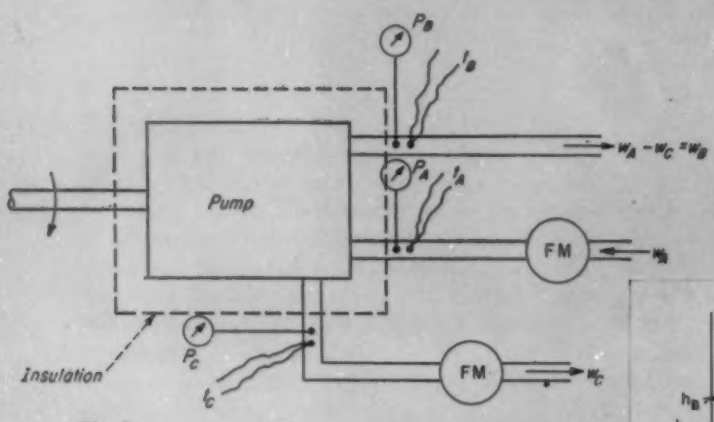


Fig. 6

Fig. 5—Where cooling port flow cannot be combined with reservoir flow two separate compression curves may be drawn on the *h-t* diagram. Curve *A-B* represents the pump flow and curve *A-C* represents the cooling port flow. Fig. 6 indicates that temperatures and pressures must be measured in three places and flow in two.

Fig. 7—Heat loss to surroundings of a pump lowers the output temperature from t_B to t_{Bo}

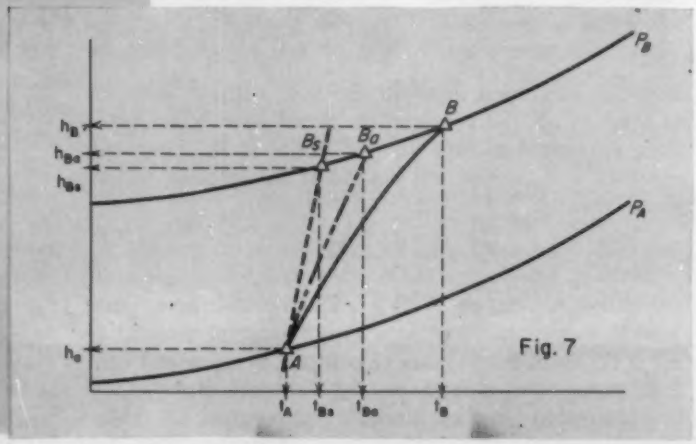


Fig. 7

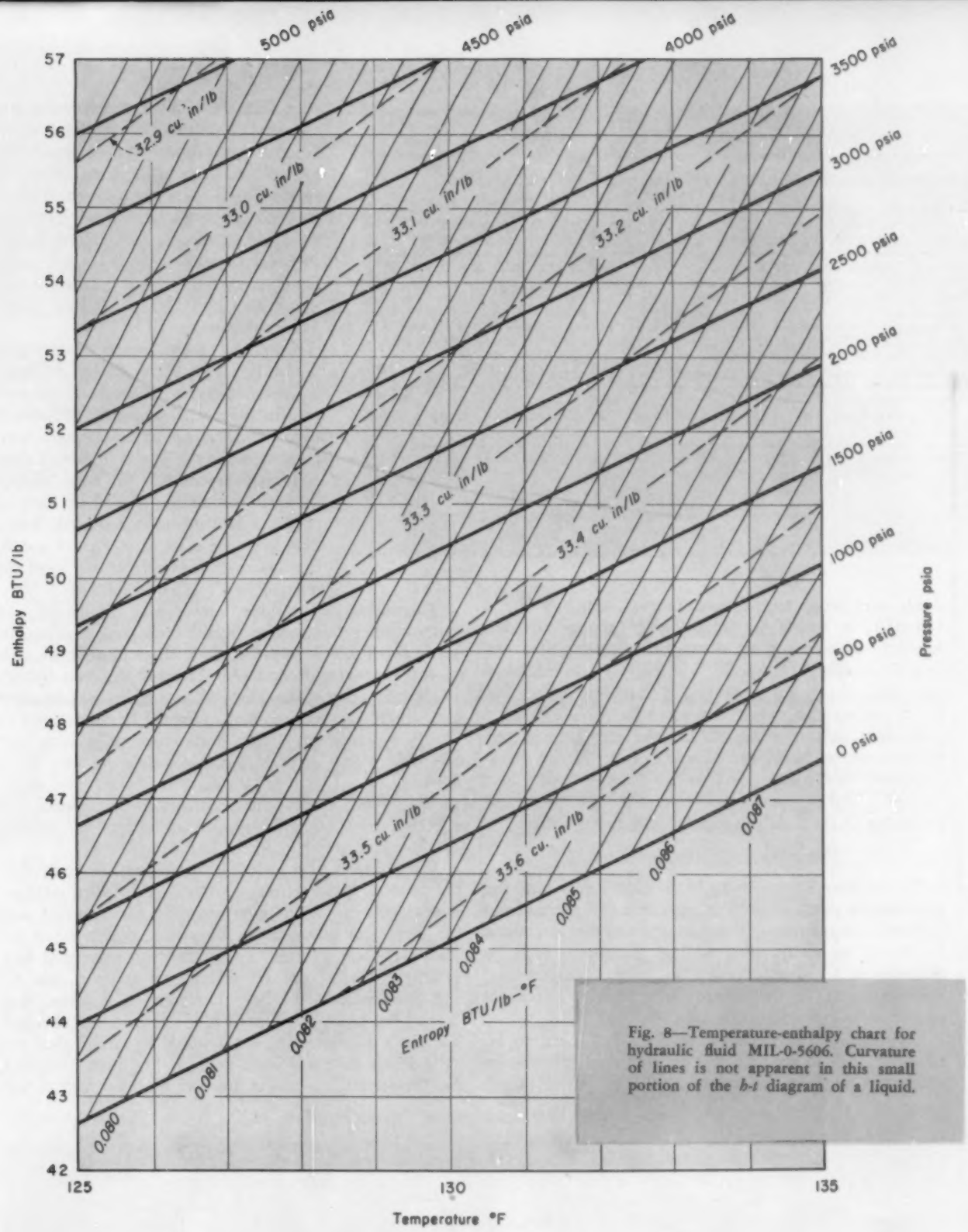


Fig. 8—Temperature-enthalpy chart for hydraulic fluid MIL-0-5606. Curvature of lines is not apparent in this small portion of the *h-t* diagram of a liquid.

particular aircraft hydraulic fluid (MIL-0-5606) was chosen to calculate a set of tables. The basic equations used are:

$$h = \int_{32}^{t} c_p\,dt + \int_{p_1}^{p_2} \left\{ \left[\frac{\partial(v\tau)}{\partial T} \right]_p dp \right\}_{T=\text{constant}}$$

$$s = \int_{32}^{t} c_p \frac{dt}{T} - \int_{p_1}^{p_2} \left\{ \left(\frac{\partial v}{\partial T} \right)_p dp \right\}_{T=\text{constant}}$$

where

c_p = specific heat at constant pressure
T = absolute temperature
t = temperature, F
$\tau = 1/T$
v = specific volume
p = pressure, absolute
s = entropy
h = enthalpy

Here both h and s were assumed zero at 32F, hence the lower limit of both integrals.

Values of $(\partial v/\partial p)_t$ have been determined for various

Table I—Temperature Measuring Techniques

Multiple Thermocouple	Single Thermocouple and Bridge	Thermistor
Low signal level leads to errors from extraneous emfs. Calibration on setup recommended.		Immune to contact resistance troubles.
Difficult to keep junction electrically separated in high pressure and temperature flow.	Extremely slow response; cumbersome setup; insulation troubles hard to detect.	Fast reading, but possible vibration troubles in connectors.
Temperature differences are read between check stations but at least one temperature must be recorded to establish absolute temperature level.		Absolute temperatures are determined for each check station.
Conversion must be made with reference to emf-tables using appropriate gradient of emf curve at temperature.		Conversion is made by reference to charts or tables.
Temperature limitations are imposed by insulating materials available to stand high hydraulic pressures.		Thermal properties above 230 F are not well known.

fluids over wide temperature ranges. Similarly $c_p = (\partial h/\partial T)_p$ is known for atmospheric pressure and was found to be constant for all normal operating pressures. Special volume v (or specific gravity $1/v$) was measured by a hydrometer in a constant temperature bath. Fig. 8 is a portion of *t-h* chart computed for MIL-0-5606.

If other properties are known, the computation procedure may be varied accordingly. Thus, if the Joule-Thomson coefficient $(\partial T/\partial p)_h$, the specific heat $(\partial h/\partial T)_p$ and the specific volume v, are measured, the properties of the fluid can also be fully determined.

Temperature Measurement

Of the three quantities to be measured only one, the temperature poses a problem not normally encountered in power computations. Both pressures and flow rates must be known no matter what method is used to find the efficiency of a hydraulic pump or motor. Temperatures, however, must be determined to accuracies rarely encountered in hydraulic work.

Often temperature changes of 5 to 7 F have to be measured. For an accuracy of 2 per cent fluid temperature differences must be determined to 0.1 F. Three means were explored to obtain the necessary precision: (1) multiple differential thermocouples with a standard thermocouple bridge (5 millivolt full scale by 100 microvolt divisions using 5 Cu-Constant junctions; (2) single differential thermocouple with precision Leeds & Northrop Bridge (Type K, sensitivity 0.1 microvolt using Cu-Con junction); and (3) calibrated thermistors with General Electric bridge and galvanometer.

While all three means were found useful, none is without its serious drawbacks for ready use in the field. In general the differential measuring techniques have the advantage of measuring a temperature difference at one instant of time and no compensation for time elapsed between readings is needed as long as only one fluid stream is measured. If two fluid flows are used as in Figs. 5 and 6, the two measurements of Δt must be referred to a common time base.

Thermistors offer more convenient installation and faster reading but require careful time compensation for readings. Table I lists the chief characteristics of each of the measuring techniques. Thermistors, even though in an early stage of development, proved more convenient and no more expensive than calibrated thermocouples in recent experiments. Better techniques of reading and recording highly accurate thermistor data are now being worked out. Extended temperature ranges are under investigation. Under these conditions thermistors are expected to show even greater advantages in thermodynamic measurements in the near future.

Temperatures in a hydraulic circuit may be controlled, but cannot be maintained constant. A so-called constant temperature in any common hydraulic circuit would send the thermistor galvanometer from stop to stop across the scale every few seconds. There are three significant temperatures which need be determined to give data for Fig. 5 accurate to 0.1 deg. If reading t_A is taken, than t_B, and last t_C, by the time it is t_C's turn, t_A has changed. To take a difference $(t_C - t_A)$ would be meaningless and yet a steady state will never exist. If the three thermistor (or thermocouple) bridges are read by three men at pre-

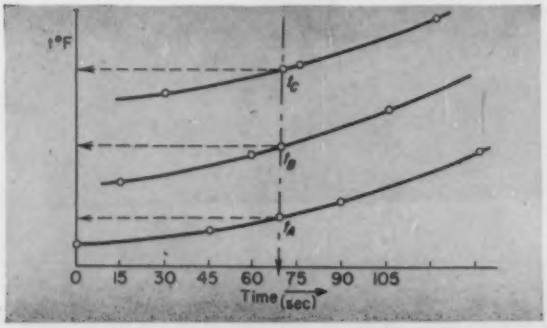


Fig. 9—Time-temperature plot of thermistor readings. Three flow temperatures are measured at fifteen second intervals and the plotting procedure permits determination of all three temperatures for one moment in time.

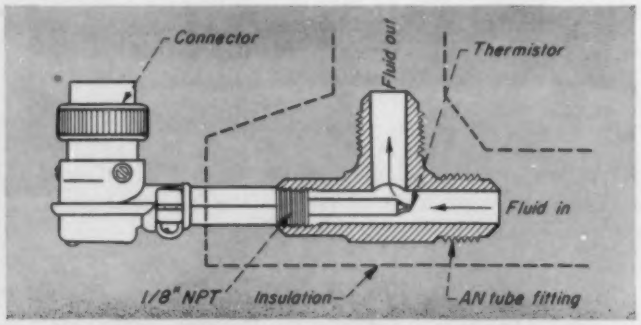
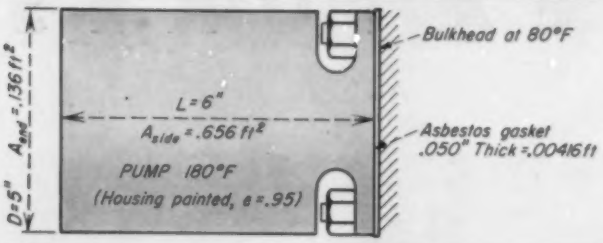


Fig. 10—Thermistor fitting for 3000 psi hydraulic line. Stagnation-pressure may raise thermistor temperature 0.1 F if fluid velocity is close to 50 ft/sec, but only 0.01 F at 15 ft/sec since temperature rise is proportional to the square of velocity.



An example of the determination of heat loss to surroundings of an uninsulated, bulkhead-mounted pump at a temperature of 180 F. Air and bulkhead temperature is assumed to be 80 F. The pump is separated from the bulkhead by an asbestos gasket .050 in. thick.

A = Area (ft²)

h = Convection coefficient $\left(\frac{\text{Btu}}{\text{hr-°F-ft}^2}\right)$

K = Conduction coefficient $\left(\frac{\text{Btu-ft}}{\text{hr-°F-ft}^2}\right)$

q_c = Convected heat (Btu/hr)
q_k = Conducted heat (Btu/hr)
q_r = Radiated heat (Btu/hr)
t = Temperature (deg F)
x = Insulation length (ft)
ϵ = Emissivity

Sample Calculation Air at 80° F

Heat conducted to bulkhead:

$$q_k = KA\frac{\Delta t}{x} \qquad \left(K_{\text{asbestos}} = .033\ \frac{\text{BTU-ft}}{\text{hr-°F-ft}^2}\right)$$

$$= .033 \times .136 \times \frac{100}{.00416}$$

$$q_k = 108\ \text{BTU/hr}$$

Heat convected to surrounding air:

$$q_c = h_{\text{cend}}A_{\text{end}}\,\Delta t + h_{\text{cbody}}A_{\text{body}}\,\Delta t$$

$$h_{\text{cend}} = .29\left(\frac{\Delta t}{D_o}\right)^{.25} \qquad h_{\text{cbody}} = .27\left(\frac{\Delta t}{D_o}\right)^{.25}$$

$$= .29\left(\frac{100}{.416}\right)^{.25} \qquad = .27\left(\frac{100}{.416}\right)^{.25}$$

$$= 1.141 \qquad = 1.063$$

$$q_c = 1.141 \times .136 \times 100 + 1.063 \times .656 \times 100$$
$$= 85\ \text{BTU/hr}$$

Heat radiated to surroundings:

$$q_r = .173A\epsilon\left[\left(\frac{t+460}{100}\right)^4 - \left(\frac{t_{\text{air}}+460}{100}\right)^4\right]$$

$\epsilon_{\text{paint}} = .95$ $\qquad A = .792\ \text{ft}^2$

$$q_r = .173 \times .792 \times .95[(6.4)^4 - (5.4)^4]$$
$$= 107\ \text{BTU/hr}$$

$$\boxed{q_{\text{total}} = 300\ \text{BTU/hr} = .118\ \text{hp}}$$

cisely the same time, all is well, but if one man with one set of equipment is willing to take nine times as long, precision can still be had by a plotting procedure. Read t_{A1}, t_{B1}, t_{C1}, t_{A2}, t_{B2}, t_{C2}, etc. in this order at 15 sec intervals and plot the result as a function of time as in Fig. 9. There will be a trend in all three temperatures and it is possible to establish t_A, t_B, and t_C for any arbitrary time.

It is conceivable that low fluid flow velocities at times of rapid temperature change may introduce appreciable errors in the temperature estimate made in Fig. 9. However, if the time for fluid particles to travel from A to B and C is known, the graph of temperatures versus time will permit elimination of this problem also.

The "where" of temperatures measurement is every bit as important as the "how" and "when" which were discussed in previous paragraphs. A thermocouple taped to a copper line cannot be expected to read the average fluid temperature to 0.1 F. There is little difficulty, however, in getting repeatable, good data by inserting the temperature-sensitive element in the middle of the fluid stream. Turbulence helps and insulation of the tube or pipe is necessary for 4 to 6 in. before and after the temperature tap.

Fluid velocity near the temperature element may affect the readings taken. Stagnation temperature rise of the order of magnitude of 0.1 F will result from fluid velocities of 50 ft/sec; at 15 ft/sec this effect is of the order of magnitude of 0.01 F and hence negligible. Fig. 10 shows a typical temperature tap.

Summary

1. The method of computing pump efficiency from a heat balance is universally applicable to any fluid power converter.

"Since this article was written we have, with the aid of IBM digital computers, cut down the computation time for the data obtained to 5 data points per minute. Raw test data measurements of temperature, pressure, and flow are used to compute input power, efficiency, output power and other quantities of secondary importance."

2. Feasibility of this method must be determined from the individual conditions of the problem.

3. It is most successfully applied to hydraulic machines when pressures are over 1500 psi and the power-to-weight ratio is high so that heat losses can be easily minimized.

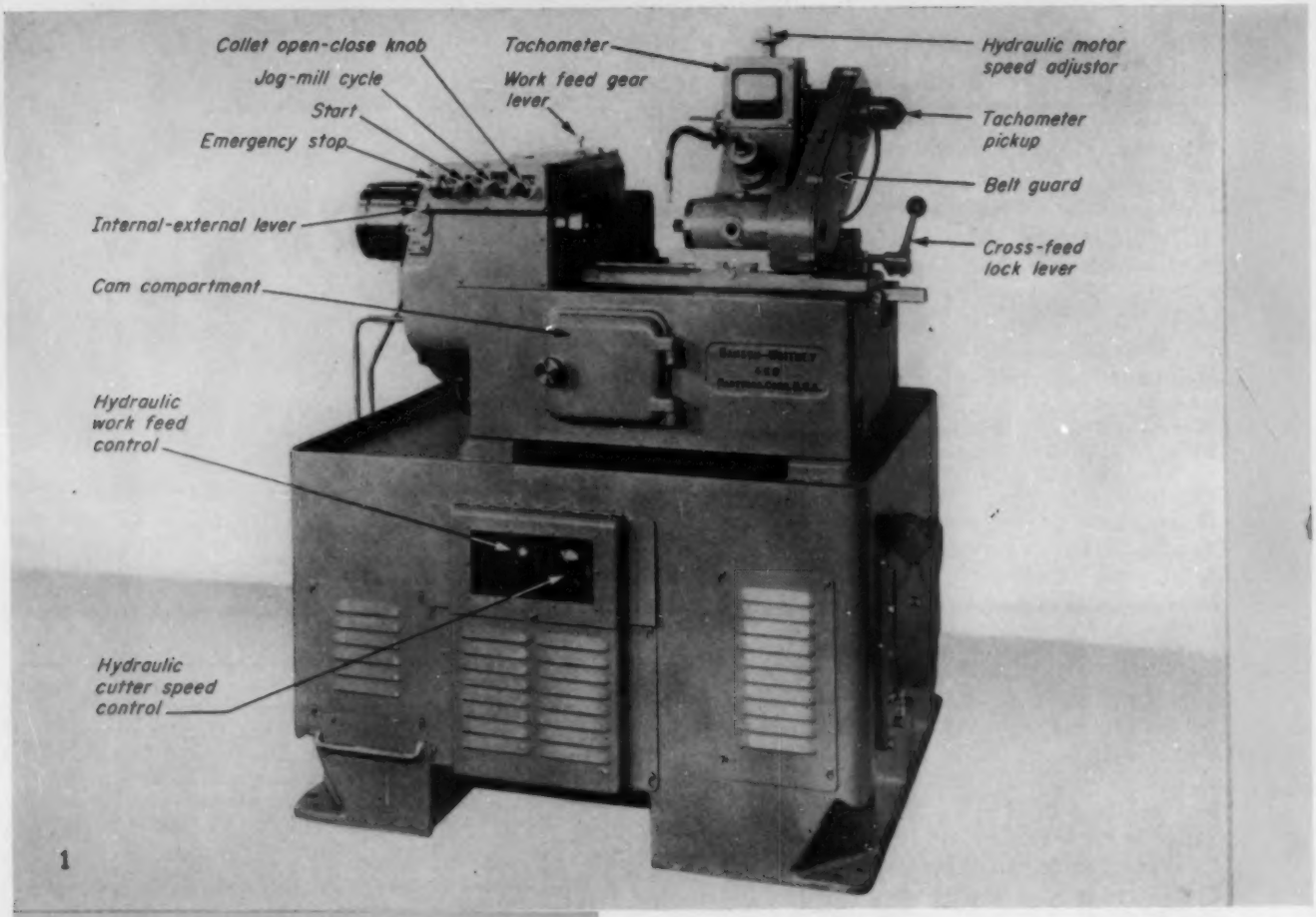
4. Thermal measurements become indispensible when torques cannot be determined because of very high speeds, inaccessible shafts, etc.

5. Accuracy of the measurements depends largely on the application, knowledge of the properties of the fluid, and ability to measure temperatures, pressures, and flows.

6. Determination of temperature corresponds to the calibration and measurement of torque in a dynamometer system; relative accuracy of measurement determines the merits of thermal versus torque measurements.

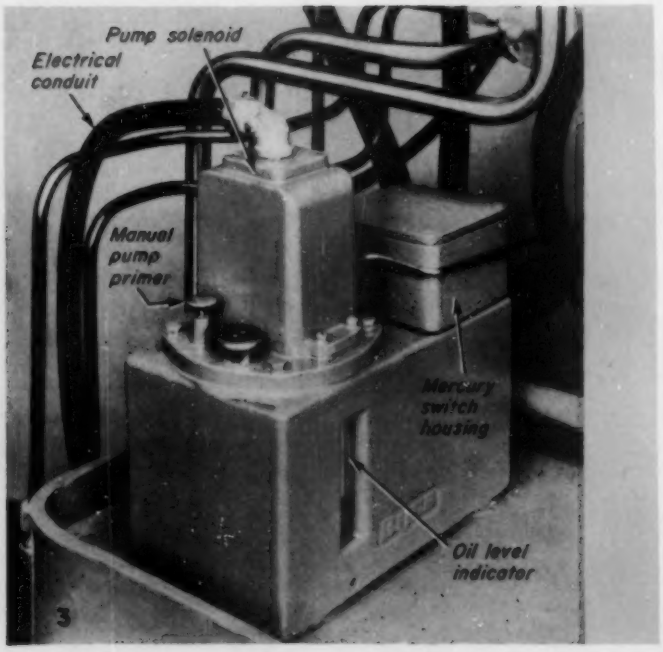
EDITOR'S NOTE—A review of piston, gear and vane pumps, their relative performance and operating characteristics appeared in *Product Engineering* for July, 1955, under the title "Hydraulic Pumps," by H. A. Vander Kaay, R. J. Murphy, and W. Traut, on page 132.

"Hydraulics for High Horsepower Applications," by M. A. Hayden, appeared in February 1955, starting on page 129. This article discusses factors influencing the design of hydraulic circuits for high power and includes sample calculations for determining pump and motor sizes.

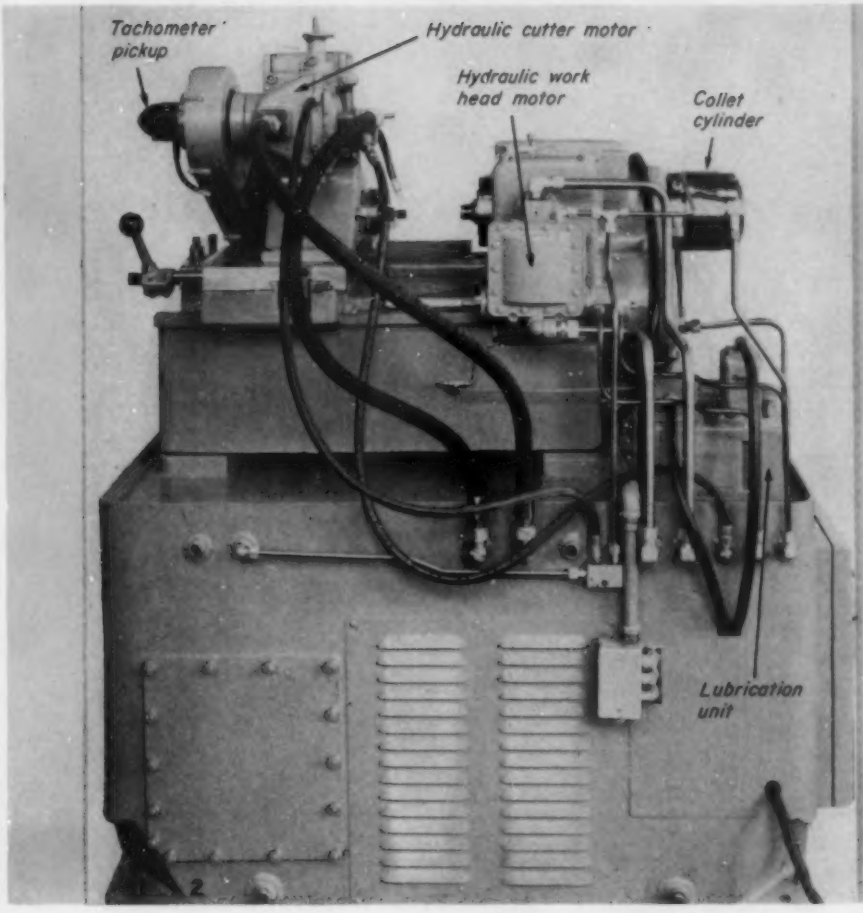


Hydraulically Driven Thread Miller

Engineers of the Hanson-Whitney Co., Hartford, Conn., have developed a machine with infinitely variable speed, hydraulic collet, interlocked controls and welded base construction.

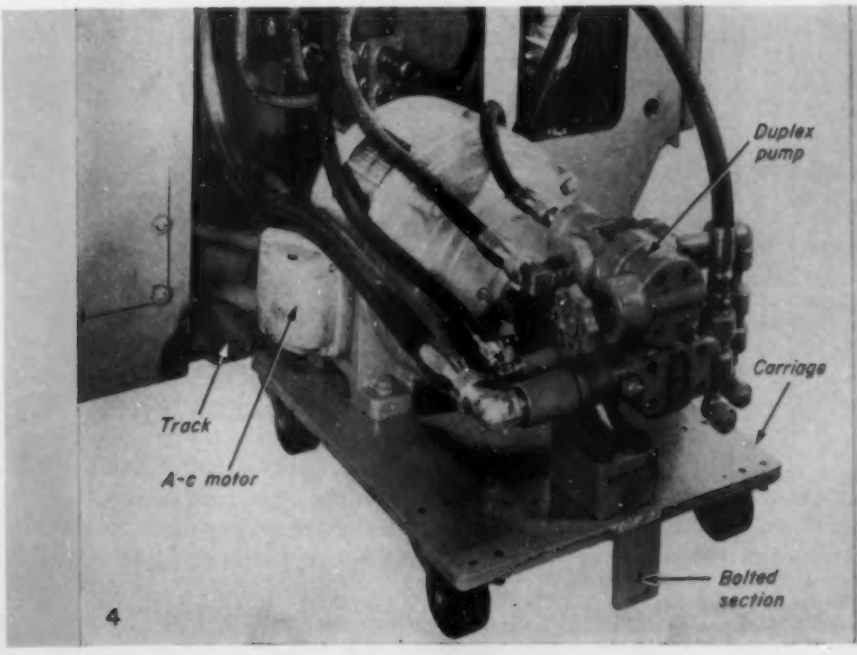


IN NEW PRODUCTS



1. Constant-volume duplex gear pump delivers oil to each of two adjustable-speed piston motors – one drives work spindle; the other drives the cutter spindle. Controls are positioned about shoulder height for left-hand operation and are in close proximity of the two spindles. Thus, the operator can have his right-hand free for making other adjustments or handling the work pieces. Adjustment of work spindle speed and variation in cutter speed can be made conveniently by manipulating metering valves at the front of the base. Speed of hydraulic motor driving the cutter is set by knob on top of carriage (behind tachometer).

2. All connections from pumps and controls to the hydraulic motors are through hoses in rear of machine. The hydraulic cylinder that closes and opens the collet is interlocked with the hydraulic motors to prevent the machine operating when collet is open. Welded base construction was chosen for economy, easier machinability and compact housing of components.

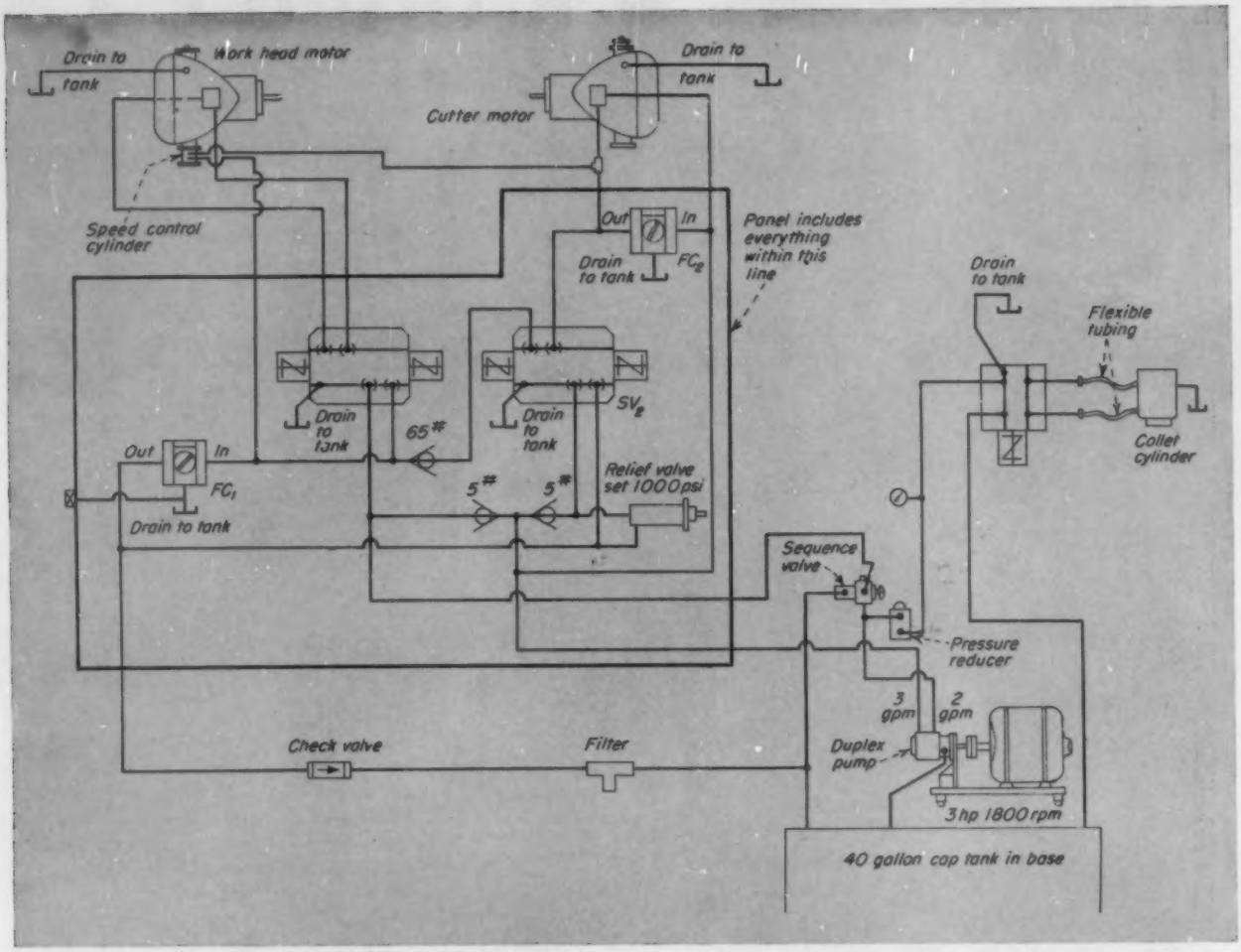


3. All bearings are lubricated from a one-shot lubricator. The lubricator piston is solenoid driven with the solenoid circuit closed when start button is pushed and automatically opened again at the end of the stroek; spring returns piston to its initial position. When oil level reaches a minimum, a mercury float switch actuates solenoid valves to shut off hydraulic oil from pumps to motors.

4. For accessibility for servicing and replacement of the hydraulic power elements, the electric driving motor and the duplex pump unit are mounted on a wheeled platform that slides on rails in the base of the machine.

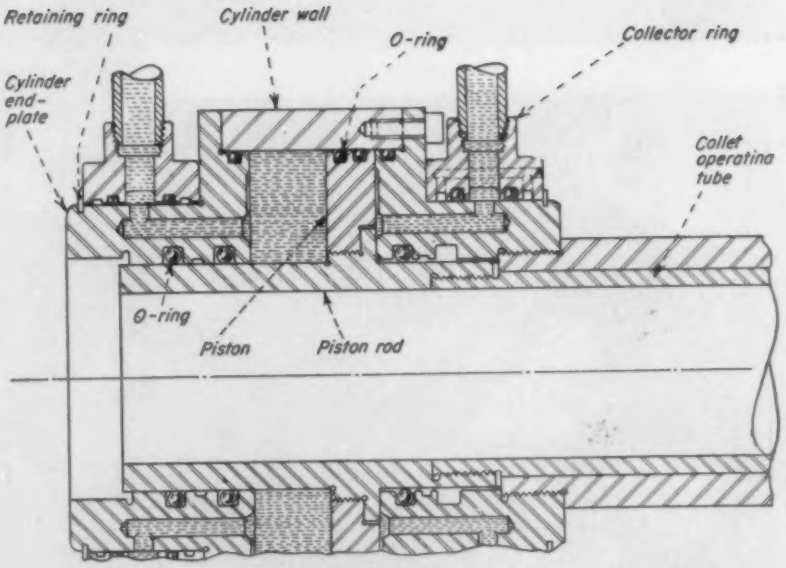
(continued on next page)

Hydraulically Driven Thread Miller (continued)



WORK-HEAD MOTOR receives power from the high-pressure 2-gpm pump which also supplies chucking power for the collet cylinder through a pressure reducing and a solenoid valve. Cutter motor is powered by the 3-gpm pump which alternately supplies power to the cutter motor and the speed control of the work-head motor.

When start button is pushed, SV_2 directs 3 gpm pump output to the speed control cylinder for the work-head motor, shifting it to high speed, driving cutter lead cam in rapid advance, with work rotating at high speed. When cutter approaches work, a limit switch shifts SV_2 to energize cutter motor, and cut off power to work-head speed control. Pressure at FC_1 reverses speed control action, slowing work-head motor and cutter lead advance. After cut is completed, SV_2 again energizes work-head speed control, rapidly retracting cutter and stopping cutter motor. At end of cycle, work-head motor stops, as limit switch neutralizes SV_1 and SV_2; sequence valve maintains collet cylinder pressure; remaining oil returns directly to tank. FC_2 can be adjusted to keep constant cutter speed FC_1 is used to adjust workhead feed. SV_1 controls work-head direction.



COLLET is closed by a hydraulic cylinder mounted on the outer end of the hollow spindle and rotating with the spindle. Hydraulic line connections are made through sealed glands as shown. When collet-operating cylinder is drawn back, collet is closed. Collet stays closed in event of power failure since solenoid controlling cylinder is de-energized when applying power. Previously, a mechanical open and close collet mechanism was used, failing to give the desired flexibility of control.

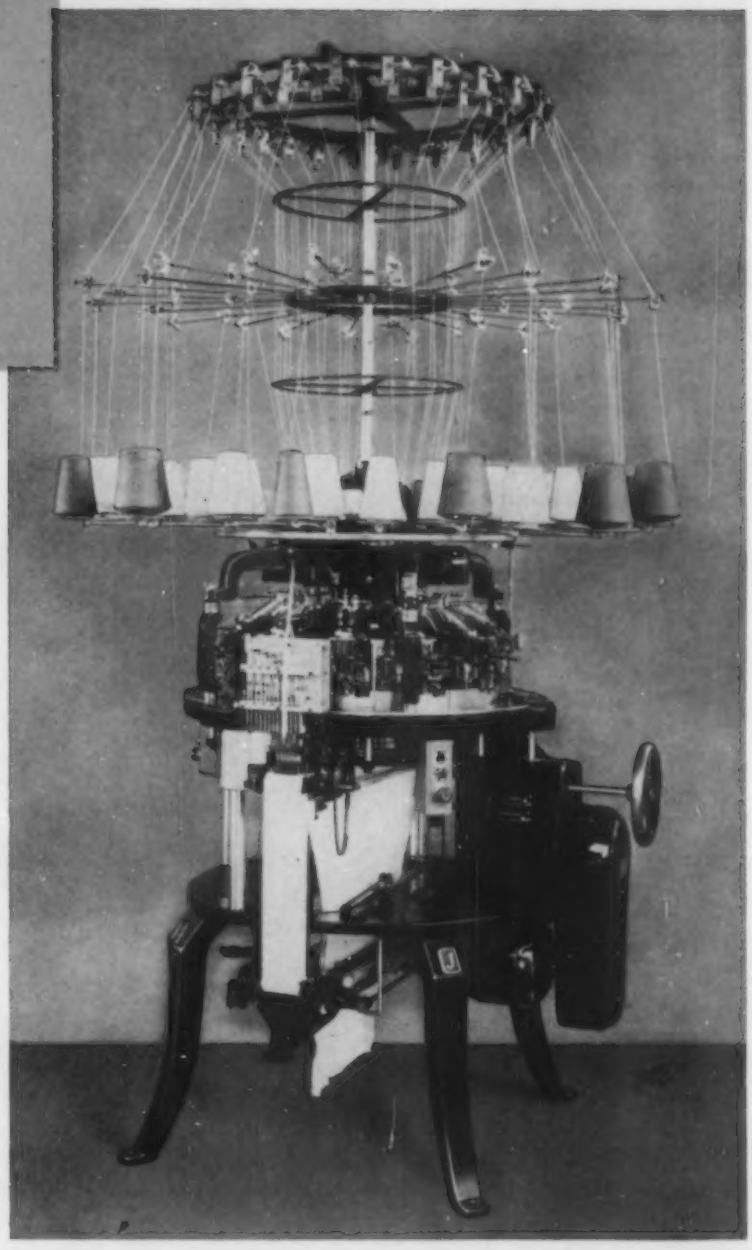
Automatic Lubricators Satisfy Dual Requirements

One obstacle facing prospective users of automatic lubrication systems is that rarely do all points on a piece of equipment require the same frequency of oiling. This problem was solved on the circular knitting machines manufactured by the Jacquard Knitting Machine Company by using two lubricators, both powered by the main motor drive of the machine, but operated separately, with individual pumps and feeding systems.

Each of the systems, produced by Bijur Lubricating Corp., consists of three elements: *lubricator,* which pumps measured amounts of oil into the system at regular intervals; *tubing lines and fittings,* that carry oil to bearings and gears to be lubricated; and *metering unit* at each lubricating point, that filters and controls the amount of oil to be dispensed.

Where individual operators formerly added oil in a random and haphazard fashion, one man now systematically fills the reservoirs of several machines in a few minutes each day.

Jacquard has already included Bijur lubricators on gear box assemblies of more than 350 of their knitting machines, and is now producing machines with automatic lubrication on the dial cap and cylinder assemblies as well. When full-scale installation is reached, Jacquard plans to have Bijur systems on most their new machines at no increase in selling price. For machines already in operation, installation can be made within a day.



FULLY-AUTOMATIC, multi-feed, circular knitting machines, manufactured by Jacquard Knitting Machine Co., Philadelphia, produce tubular fabric in body lengths. Machines are powered by a 1½ hp electric motor, which drives revolving cam boxes around a stationary needle dial and cylinder.

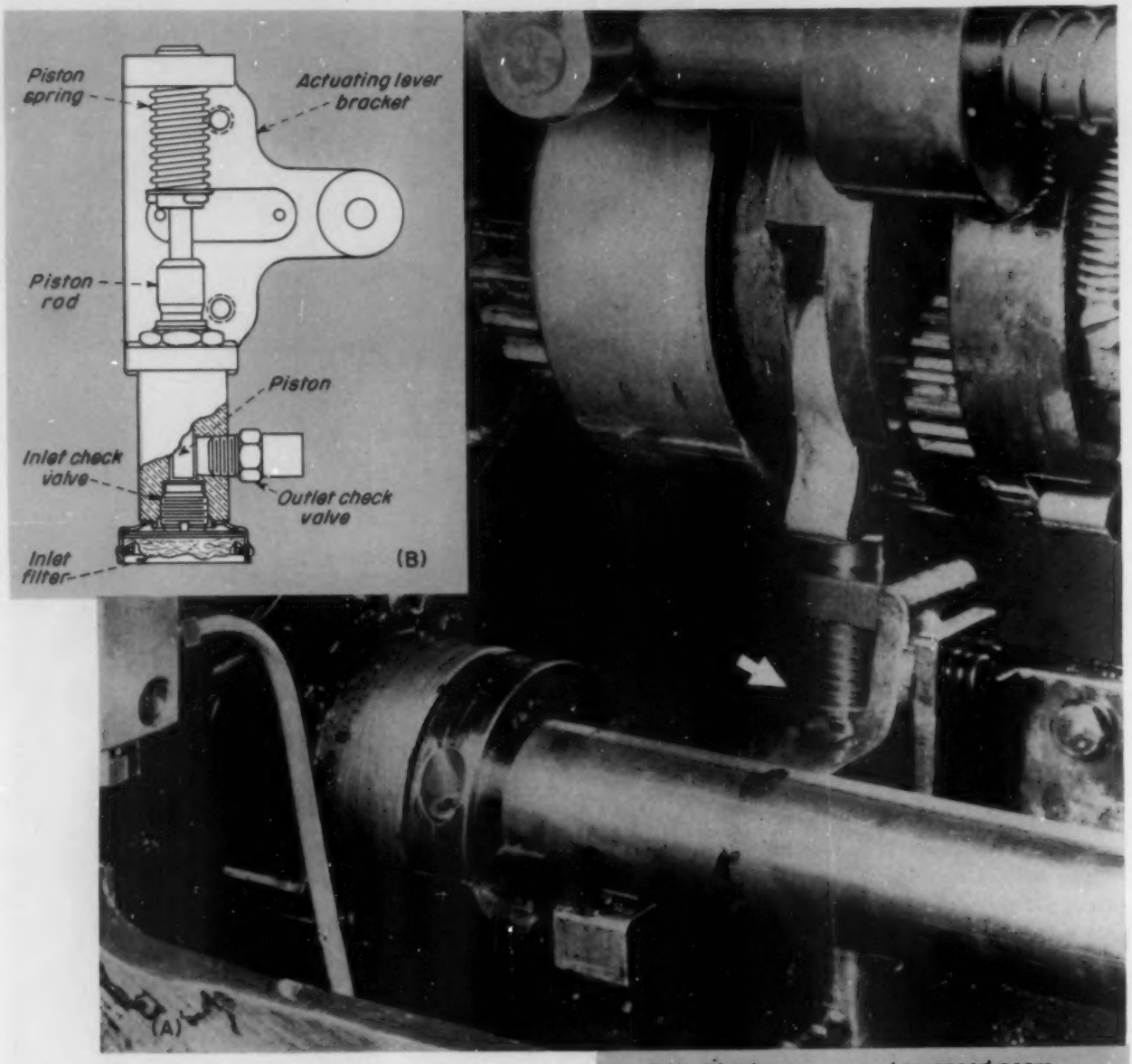
Key parts to be lubricated are: (1) dial and cylinder needles and two bearings on the dial cap; and (2) four sets of gears in the reduction drive of the motor.

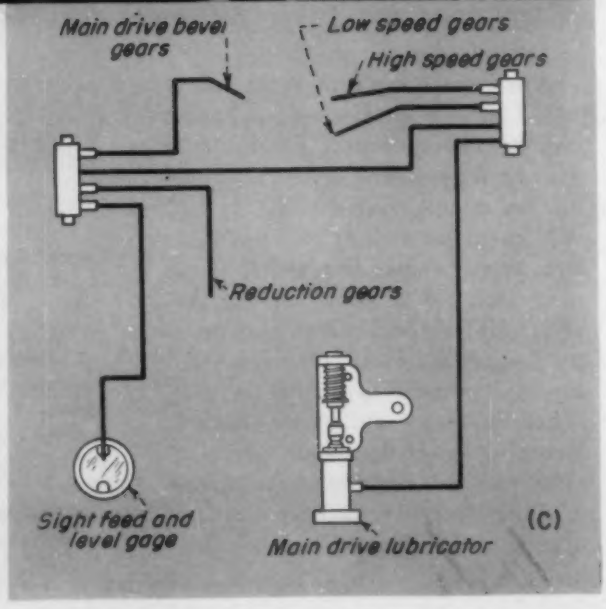
Manual lubrication which was formerly done by the machine's operator proved unsatisfactory. Some parts got too much oil; the excess drained down onto the material as it was knitted causing spoilage. Other parts got too little oil; friction between moving parts caused excessive wear. Needle butts broke because of lack of lubricant; drive gears, not properly lubricated, failed far short of their expected life.

Automatic lubrication applied here reduced downtime, eliminated product spoilage and gave longer life for the machine parts.

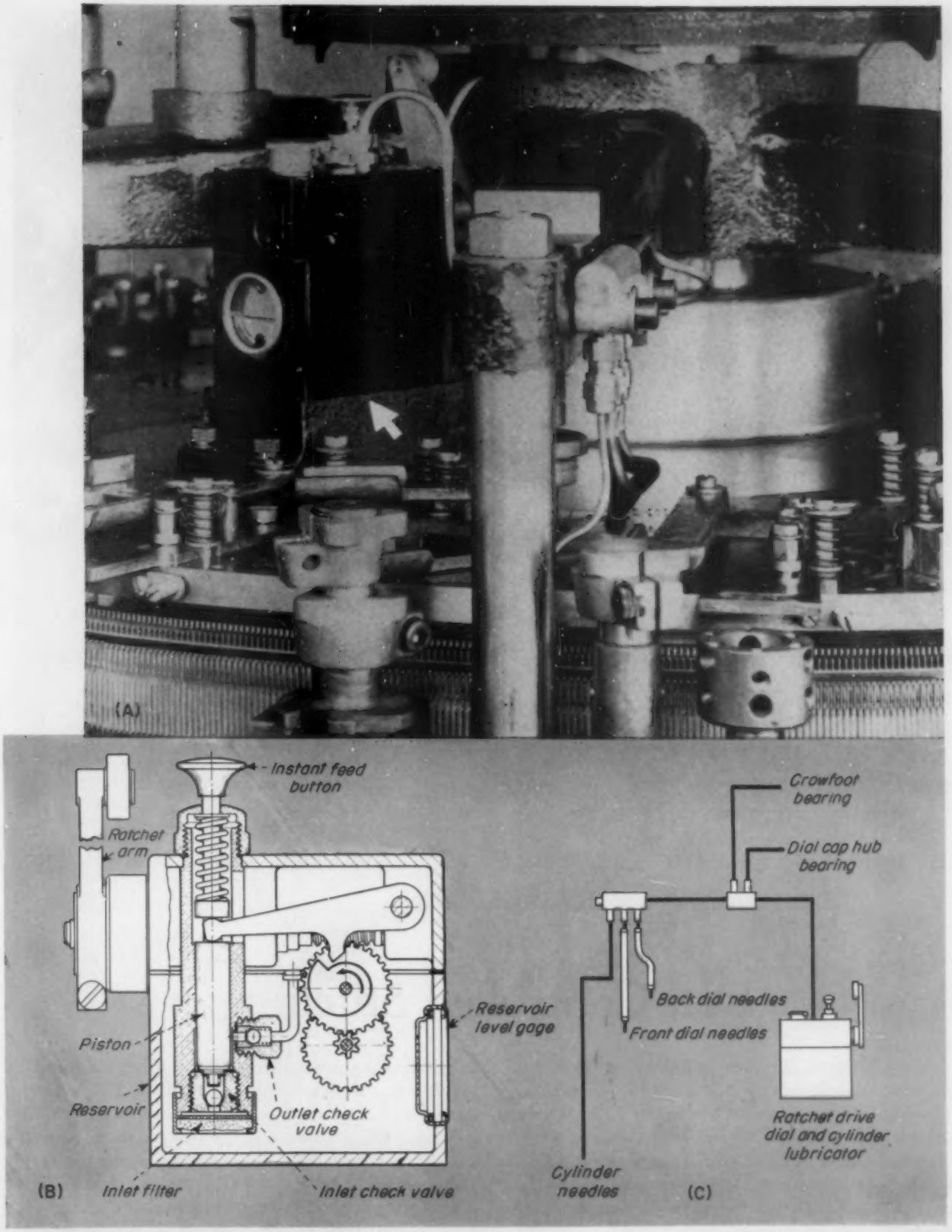
(continued on next page)

Automatic Lubricators (continued)

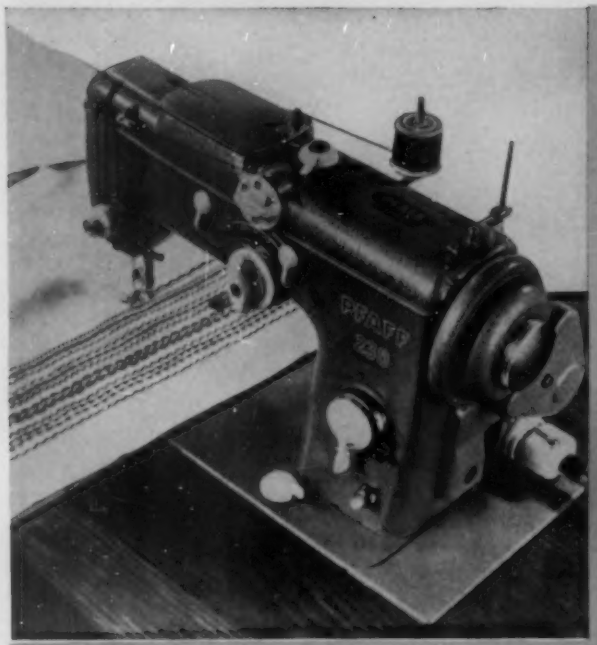


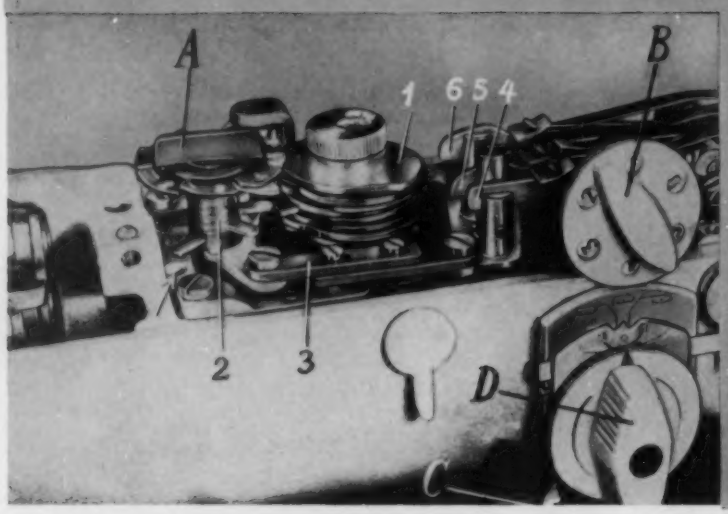


GEAR BOX LUBRICATOR is a continuous type piston pump, actuated by an eccentric cam on the shaft in the motor drive (A). A rotating cam lifts the rocker arm, which raises the piston and compresses a spring inside the lubricator. The rising piston draws oil from the reservoir through a felt filter and valve (B). The cam then releases the rocker arm and the piston is forced down by the spring, pumping oil into the distribution system. Oil is pumped continuously from the 2-quart sump at the bottom of the gear box into the single-line distribution system, composed of $\frac{1}{8}$ in. tubing with branch lines transmitting oil from main line to lubrication points. One branch of the system goes to an oil window, which indicates flow and shows that the system is functioning (C). At each lubricating point a metering unit filters and measures the exact amount of oil required by the specific set of gears. Oil pressure, transmitted from the lubricator pump through the distribution system, forces oil into each unit. The size of the orifice determines the amount of oil that will go onto the gear. A check valve at the outlet of the meter insures flow in a single direction to prevent drain-back, and always keeps the system full of oil.



LUBRICATOR for dial cap and cylinder system (A) is a small ratchet-drive cyclic pump with its own reservoir. Sketch (B) shows its construction and identifies important components. Lubricator rotates with the dial hub and is actuated by a series of drive cams mounted on the overhead stationary hub of the machine. Normally, the reservoir which holds 80 cc of oil is filled every 24 hr. Oil is filtered at pump inlet, fed into distributing system (C) and through metering units to lubrication points.



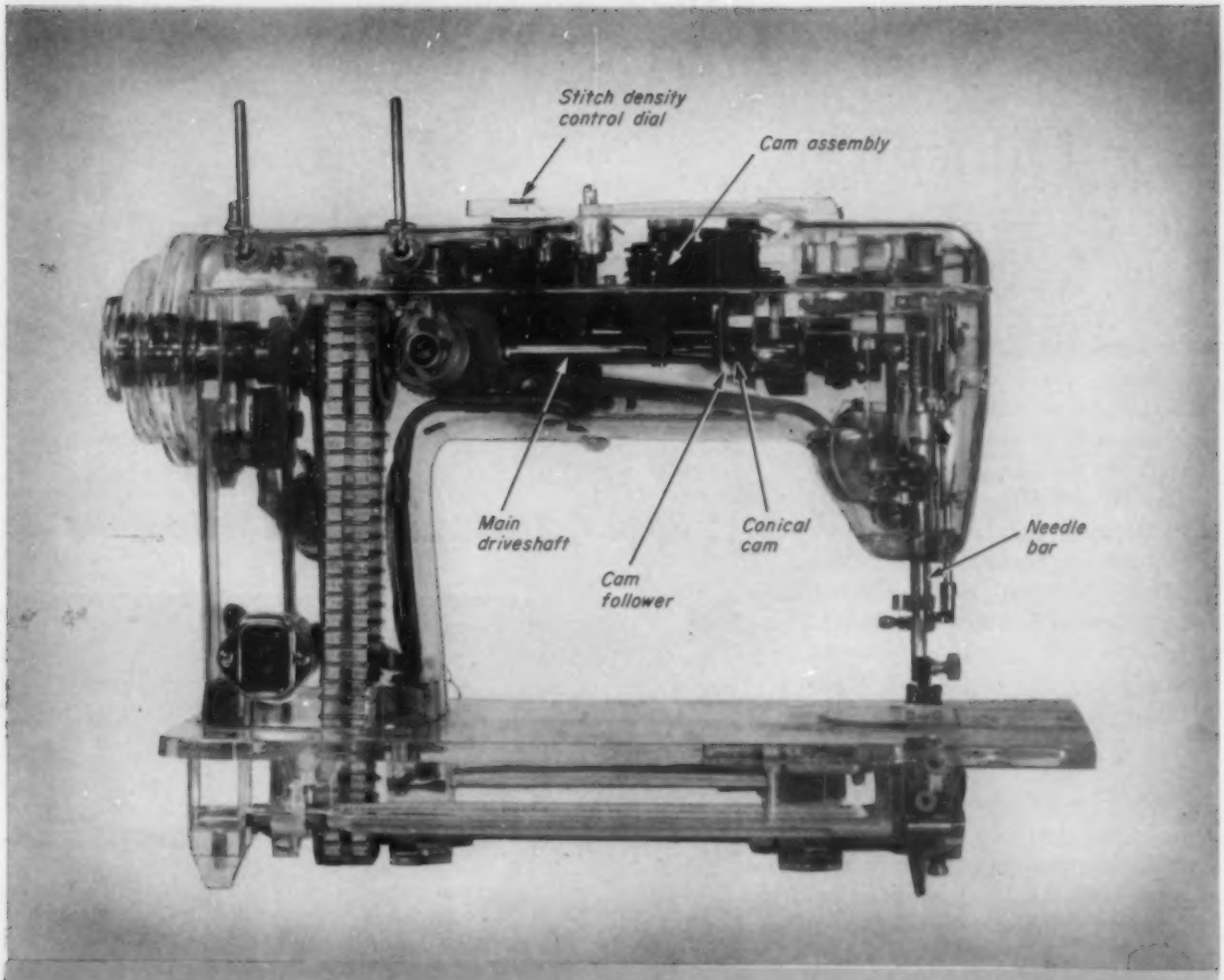


WITH THE ADDITION of the new control assembly, five dials shown above right determine the stitch pattern. *A*—Cam selector dial (under cover on top of arm) supplies a cyclic pattern to lateral shift of needle by engaging one of eight cams in the cam assembly *1* with a feeler *2*, as shown at left. *B*—Design selector engages one or more of three shift bars *4*, *5* and *6* to change width or position of stitch in a repetitive pattern. *C*—This lever shifts position of needle from center to extreme right or extreme left of lateral stitch pattern. *D*—Continuous adjustment manual control for width of zig-zag stitch. *E*—Manual adjustment for stitch density; while continuously adjustable over the range, dial has seven numbered positions to aid in producing a specific pattern.

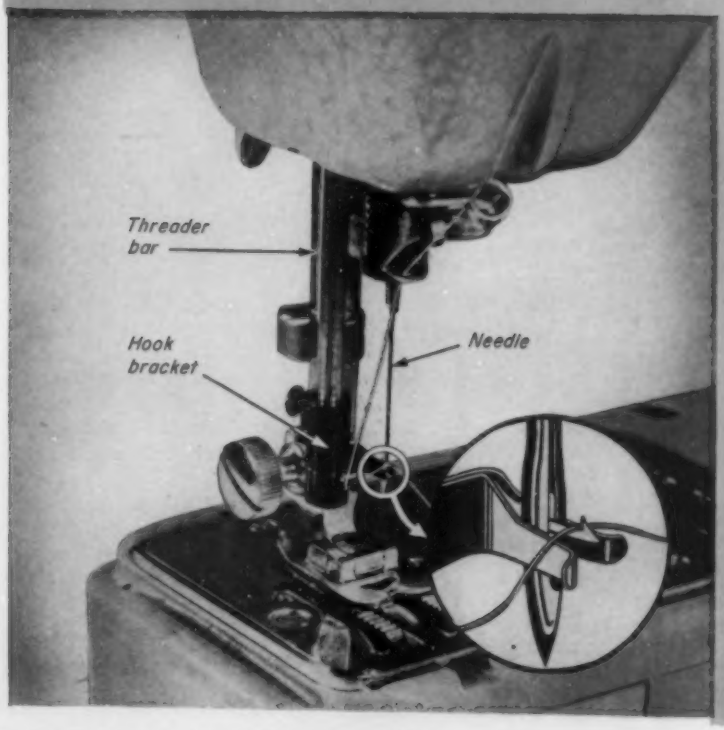
Dial Controlled Stitching

New sewing machine, developed by the Pfaff Company, Kaiserslautern, Germany and now available here, automatically provides more than 80 basic types of stitches, each with seven selected stitch densities, with no interchanging of cams or parts. Control is provided by five built-in adjustments with numbered dials; dial settings are selected from a chart keyed to a diagram of the stitch.

Representing the completion of a two-stage development, the earlier model placed on the market two years ago had three independent control adjustments: stitch length, lateral position of needle, and stitch width (zig-zag or range of lateral swing). Each of these adjustments produced a fixed stitch, unchanged during sewing unless the dial was manually changed. New control assembly designed into space available in the top arm of the machine adds a cyclic pattern both to the lateral shift of the needle and to the stitch width or zig-zag. A third control varies the stitch density or the number of stitches in a cyclic pattern. Only change to the basic machine is the addition of one cam to the main drive shaft and insertion of the control assembly.



REAR VIEW of a special demonstration model with transparent plastic housing. Stitch density within a selected cyclic pattern is controlled by a conical cam on main shaft; position of follower along the conical cam axis—and therefore the range of travel—is adjusted by the control dial. Intermittent motion of cam follower rotates the 8-cam assembly through a one-way clutch thus varying the number of stitches required to produce one revolution of the cam.

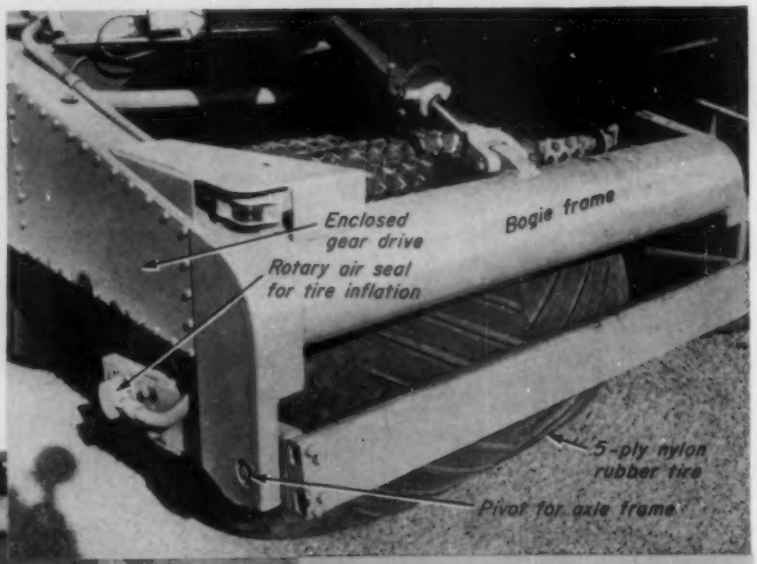


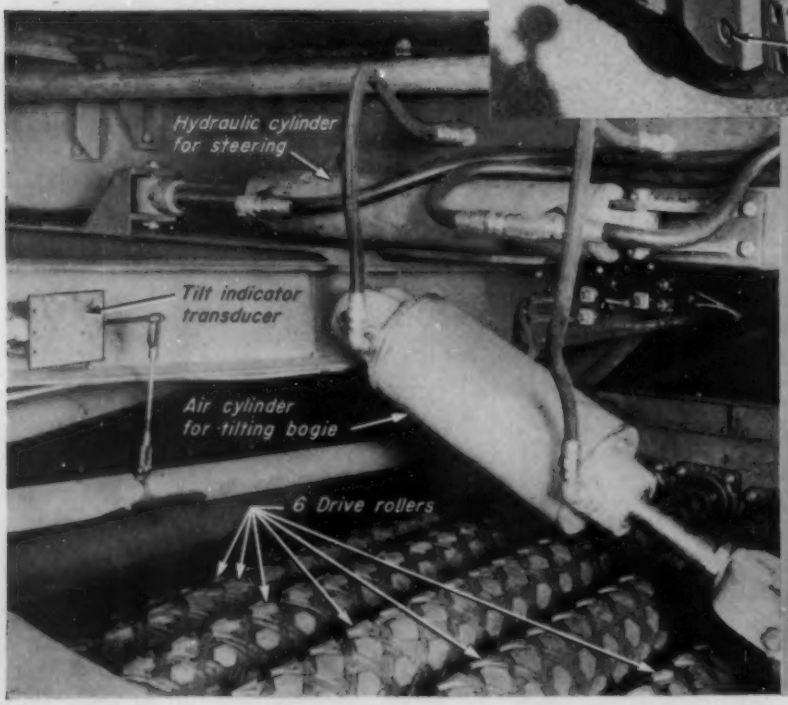
FOR AUTOMATIC NEEDLE THREADING (an exclusive Praff feature) the needle bar is placed in its highest position, and a lever at rear of head lowers a threader bar to a stop which brings hook on level with eye of needle. Further motion of lever rotates the hook through the eye as illustrated. Thread is placed over hook and lever released, threading the needle and lifting threader bar up and out of the way.

Cargo Carrier for Difficult Terrain

To successfully carry a 10-ton cargo over arctic snow, desert sand and rocks, or soft swampy ground, major requirement is to reduce unit ground pressure. In the Teracruzer, developed by Four Wheel Drive Auto Company in cooperation with Army Ordnance Corps, this was accomplished by using Goodyear Rolligon tires — melon-shaped nylon and rubber bags inflated to only 3 to 5 psi. Eight tires are mounted in pairs on four bogies, two bogies side by side at front and rear. No springs are needed.

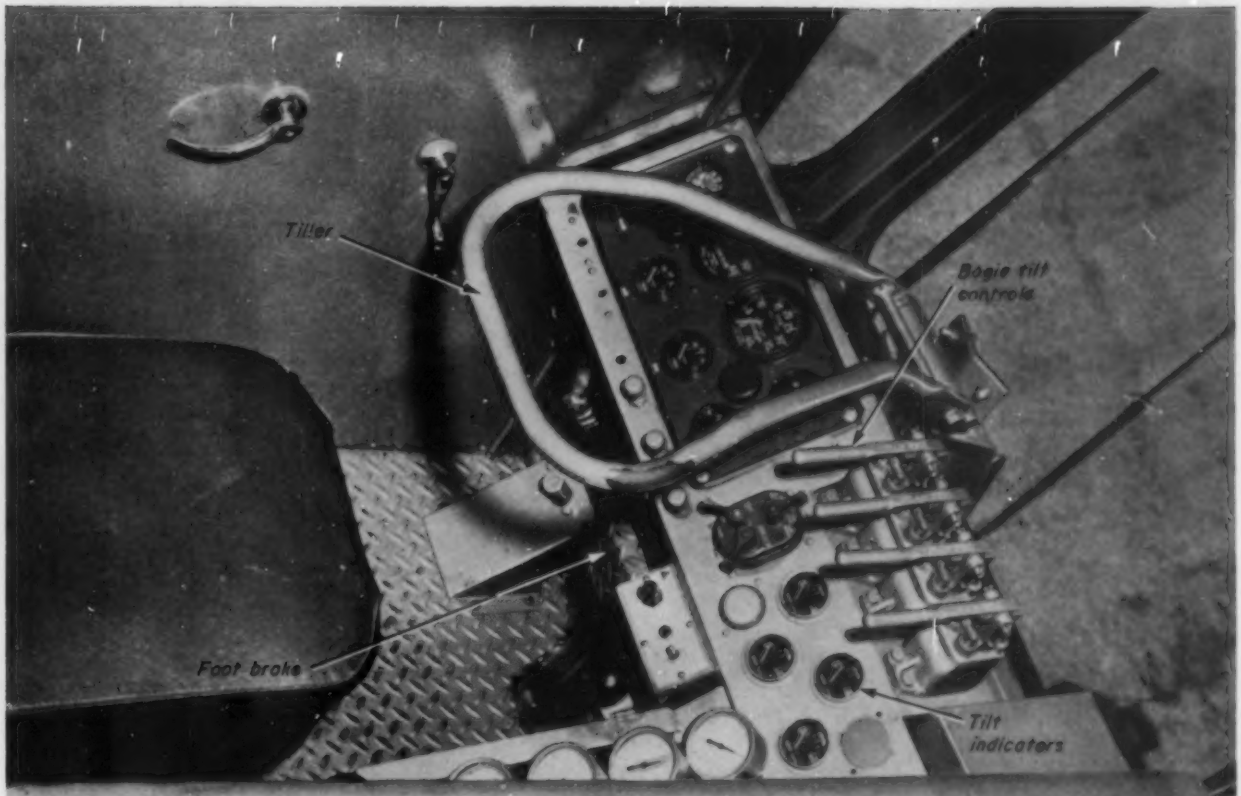
Design problems faced in developing this carrier included: mounting and driving each tire; power steering; independent control of air pressure in each tire from the driver position; and adjustment of weight distribution to meet surface conditions.



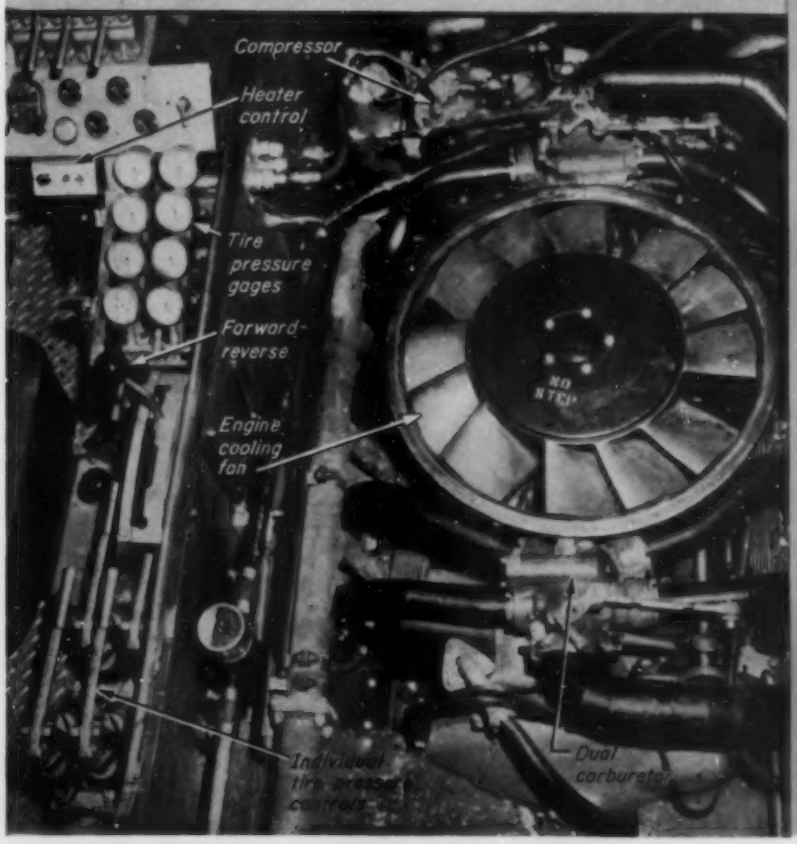


TIRES are 5 ft long and 3½ ft in diameter; each tire is supported on its own axle and guided by a pivoted frame. Air to each tire is supplied through a rotary seal on the outer end of the axle. Weight of vehicle is applied to top of tire (rather than through axle) by a series of six rubber-surfaced rollers that also drive the tire to supply propulsion. Rollers are driven by enclosed gearing; chain was considered but required means for adjustment.

Bogie mounting of tire pairs gives flexibility needed for rough terrain; bogies can pivot to equalize load, or may be tilted by pneumatic power to reduce load on leading or trailing tire. Use of air instead of hydraulic power for tilting provides desirable cushioning.



Engine compartment



FRONT BOGIE is "fifth wheel" mounted for steering, with steering power supplied by two double-acting hydraulic cylinders controlled by a tiller in the driver compartment, as shown above. Driver position is at left of engine and, in addition to usual instruments and controls, includes four air valves for tilting bogies, plus indicators showing the actual tilt of each bogie as sensed by a transducer mounted on the bogie supporting frame.

At driver's right, next to engine compartment (shown at left with cover raised) are the eight valves for controlling pressure in each tire, and indicators showing the pressure in each tire. Air compressor delivering 12 cfm is mounted on front of engine. Rotating air seals allow inflation of tires while vehicle is in motion.

Power is supplied by a 340-hp 8-cyl air-cooled engine through a torque converter and six-speed automatic transmission. Mechanical braking is applied by a disk-type brake on each bogie drive shaft; a dynamic hydraulic brake is also designed into the automatic transmission.

AMPLIFIER is 8½ in. high, 11¼ in. deep and 17¾ in. long; weighs 50 lb. A single meter checks carrier voltage and output of each of the four amplifiers, with neon lamps indicating the circuit being checked. Each channel has its own controls for attenuation, amplitude and phase balance, and gain. Multiple position power and meter selector switches are used.

Controls are small enough for adequate finger clearance, yet large enough for easy manipulation. Individual grouping of controls for each amplifier on pads of a deeper hue of the panel color provided needed separation to avoid error in operation. Control shafts have locking nuts and plug-in components are clamped to secure against vibration.

Amplifier Packaged for Resistance to Shock and Humidity

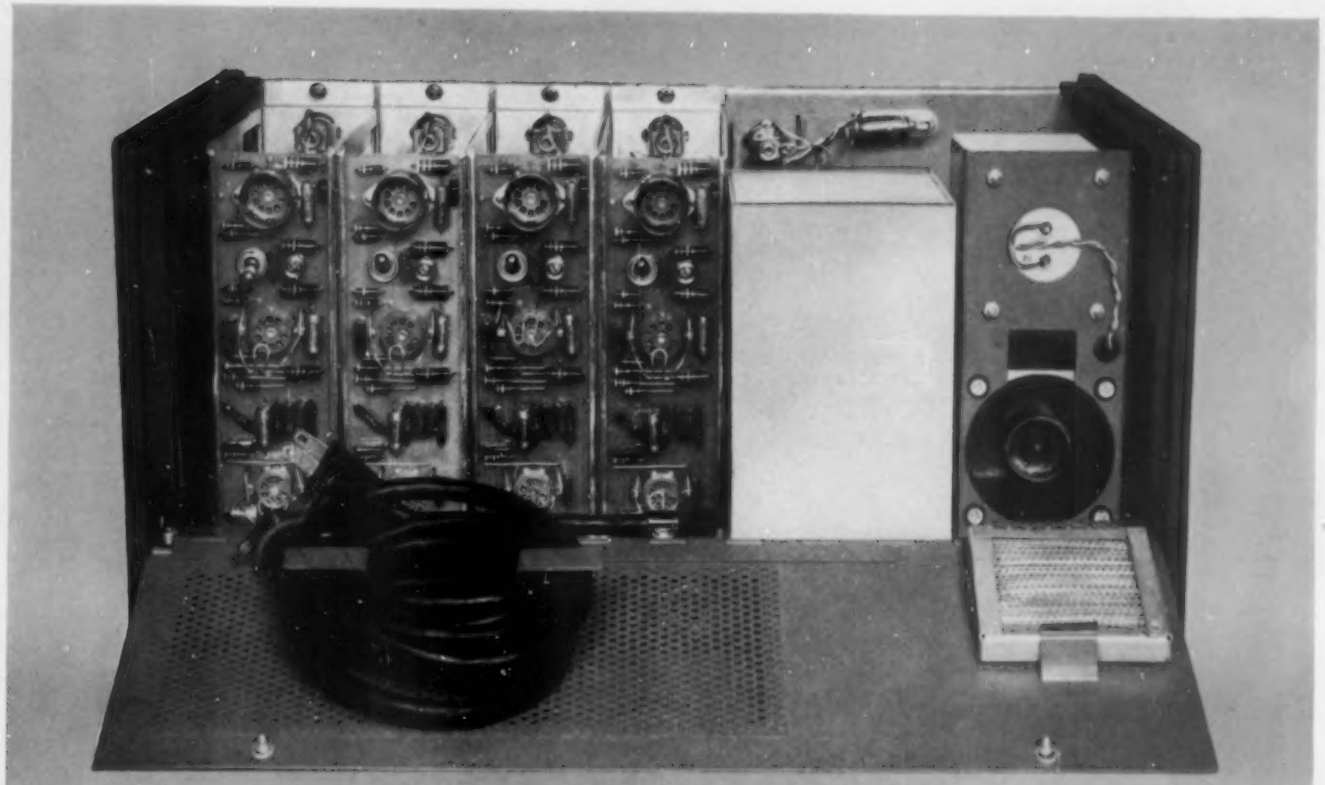
New types of variable-reluctance and differential-transformer transducers, developed by Consolidated Engineering Corp., Pasadena, Cal., had greater range and higher sensitivity than earlier types. This, in turn, called for recorder amplifiers of wider frequency range and faster response, and led to development of the Type 1-127 carrier amplifier.

Measuring and recording transients in internal combustion engines, stresses in aircraft wings, and high-frequency vibration in other types of motion, called for a package unit with a 20-kc oscillator and power supply, a calibrating system and four channels with a frequency range of 0 to 3000 cps. Equipment had to operate under 95 per cent relative humidity.

Germanium diodes were desirable for space considerations but presented a problem in temperature control. A shock resistant mounting and enclosure was required, and controls had to retain settings under heavy vibration. A high level of reliability was important, with simple operation, easy maintenance, and minimum space.

To achieve these objectives, the design incorporates cellular amplifier units, dip-soldered printed circuits, a built-in blower with filter, and restraining and locking devices.

For different installations and varying numbers of channels, unit can be mounted four ways.

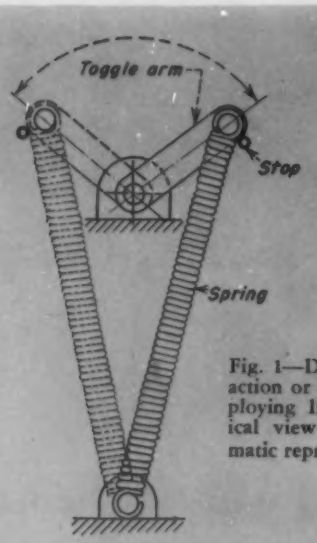


REAR VIEW with top removed and back panel open. Cabinet ends are cast aluminum to add rigidity and ability to withstand shock loads; sheet metal panels are of heavier thickness also. When used with a shock mounted base, amplifier will withstand a shock of 15 g horizontal and 30 g vertical. All plug-in components are secured with clamps.

Cellular construction gave greater component density while increasing the ease of assembly. Fan and filter are at lower right; to give germanium diodes priority on the cooling air, they were located nearest the blower. Air was then circulated through channels formed by cutouts in the side walls of each cell past the high-dissipation keying tubes. Air was exhausted out the rear of the cabinet past the voltage amplification tubes. Effective cooling was thus obtained even with the high component density. Rear panel is hinged for access to blower intake air filter and tubes.

FOR OPTIMUM STABILITY in critical amplifier circuits, the amplifier was designed for printed wiring. Epoxy glass was selected for the printed circuit base because of its low moisture absorption. All printed circuit elements are confined to one side of the plate. Components are assembled on the other side and dip soldered. A final coating of epoxy resin is applied over the soldered side for additional protection against high humidity.

Instrument can be bench mounted as single or multiple unit with or without shockproof base. Units are interlocked by two pins on top panel of lower unit engaging slotted slide on bottom panel of upper unit. Unit can be rack-mounted by placing screws in tapped cabinet end holes for angle attachment.



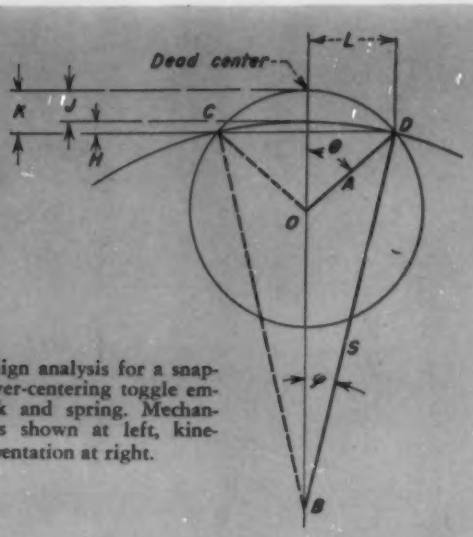


Fig. 1—Design analysis for a snap-action or over-centering toggle employing link and spring. Mechanical view is shown at left, kinematic representation at right.

SYMBOLS

- A = length of toggle arm
- S = free length of toggle spring in detented position
- θ = angle swept by toggle arm moving from detented to dead center position
- φ = angle swept by toggle spring in moving from detented to dead center position
- CD = chordal distance between detent points
- L = chordal distance between detent point and dead center
- K = height of arc swept by toggle arm
- O = pivot point of toggle arm
- B = pivot point of toggle spring

Designing Snap-Action

ERWIN F. C. SCHULZE
Remington Rand, Division of Sperry Rand Corp., South Norwalk, Conn.

OVER-CENTERING TOGGLE MECHANISMS, Fig. 1, are widely used in mechanical and electrical switches, latch mechanisms and mechanical overload controls. Such toggles also serve as: (1) detent (holds other parts in selected position); (2) overload device in a mechanical linkage (shifts to opposite position when sufficiently loaded); and (3) energy storage device.

Two applications shown in Fig. 2 illustrate the "snap-action" of a toggle. As the toggle passes dead center it is snapped ahead of the actuating force by the toggle spring. In most applications it is desirable to obtain maximum snap action.

Snap-action is a function of the elongation per length of the toggle spring as it moves over dead center. Elongation at dead center is equal to:

$$J = K - H \quad (1)$$

The elongation e in per cent of length is equal to:

$$e = (100)J/S \quad (2)$$

Since the resisting force of the spring increases with elongation but decreases with an increase in length, the ratio J/S should be as large as possible within the capacity of the spring for best snap-action performance.

The ratio J/S as a function of angle θ can be derived as follows:

$$H = S - S\cos\varphi \quad (3)$$

and

$$K = A - A\cos\theta \quad (4)$$

Substituting Eqs (3) and (4) into Eq (1),

$$J = A(1 - \cos\theta) - S(1 - \cos\varphi) \quad (5)$$

or

$$J/S = (A/S)(1 - \cos\theta) - (1 - \cos\varphi) \quad (6)$$

The relationship between θ and ϕ is:

$$L = A\sin\theta = S\sin\varphi$$

or

$$\sin\varphi = (A/S)(\sin\theta) \quad (7)$$

By trigonometric identity,

$$\sin\theta = (1 - \cos^2\theta)^{1/2} \quad (8)$$

Substituting Eq (8) into Eq (7) and squaring both sides,

$$\sin\varphi^2 = (A/S)^2(1 - \cos^2\theta) \quad (9)$$

By trigonometric identity,

$$\cos\varphi = (1 - \sin^2\varphi)^{1/2} \quad (10)$$

Substituting Eq (9) into Eq (10),

$$\cos\varphi = [1 - (A/S)^2 + (A/S)^2\cos^2\theta]^{1/2} \quad (11)$$

and Eq (11) into Eq (6),

$$J/S = (A/S)(1 - \cos\theta) - 1 + [1 - (A/S)^2 - (A/S)^2\cos^2\theta]^{1/2} \quad (12)$$

Eq (12 can be considered as having only three variables: (1) the spring elongation ratio J/S; (2) the toggle arm to spring length ratio, A/S; and (3) the toggle arm angle θ.

A series of curves are plotted from Eq (12) showing the relationship between J/S and A/S for various angles of θ. The curves are illustrated in Fig. 3; for greater accuracy each chart uses a different vertical scale.

Maximum Snap-Action

Maximum snap-action for a particular angle occurs when J/S is a maximum. This can be determined by setting the first derivative of Eq (12) equal to zero and solving for A/S.

Differentiating Eq (12),

$$\frac{d(J/S)}{d(A/S)} = 1 - \cos\theta + \frac{[-2(A/S) + 2(A/S)(\cos^2\theta)]}{2[1 - (A/S)^2 + (A/S)^2\cos^2\theta]^{1/2}} \quad (13)$$

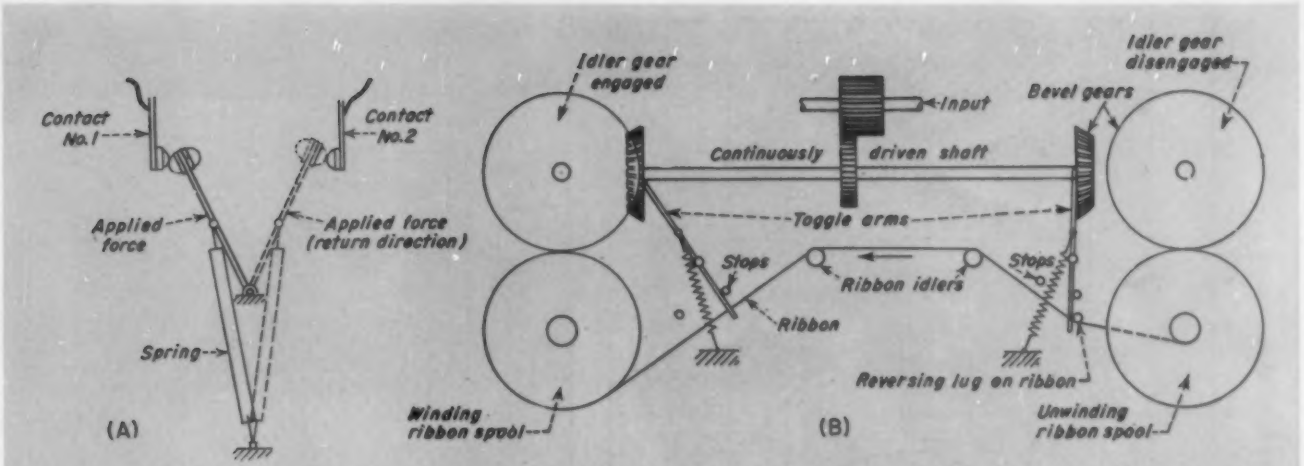


Fig. 2—Typical applications of toggles: (A) snap-action switches; (B) ribbon reversing mechanism for typewriters and calculators. The toggle in (B) is activated by a lug on the ribbon. As it passes dead center it is snapped ahead of the lug by the toggle spring, thus shifting the shaft and reversing the direction of the ribbon before next key is struck.

Toggles

Theory, formulas and design charts for quickly determining toggle dimensions to obtain maximum snap- action.

Setting Eq (13) equal to zero and rearranging terms,

$$\frac{\cos\theta - 1}{\cos^2\theta - 1} = \frac{A/S}{(A/S)[(S/A)^2 - 1 + \cos^2\theta]^{1/2}} \quad (14)$$

Cross-multiplying, squaring and simplifying,

$$(S/A)^2 - 1 + \cos^2\theta = \cos^2\theta + 2\cos\theta + 1$$

Reducing,

$$(S/A)^2 = 2\cos\theta + 2$$

and finally simplifying to the following equation of A/S when J/S is a maximum:

$$A/S = [2(\cos\theta + 1)]^{-1/2} \quad (15)$$

The maximum value of J/S can be determined by substituting Eq (15) into Eq (12):

$$J/S_{max} = \frac{1 - \cos\theta}{[2(\cos\theta + 1)]^{1/2}} - 1 + \left[1 - \frac{1}{2(\cos\theta+1)} + \frac{\cos^2\theta}{2(\cos\theta+1)}\right]^{1/2} \quad (16)$$

which is simplified into the following expression:

$$J/S_{max} = \frac{2 - [2(\cos\theta + 1)]^{1/2}}{[2(\cos\theta + 1)]^{1/2}} \quad (17)$$

The locus of points of J/S_{max} is a straight line function as shown in Fig. 3. It can be seen from Eq (15) that the value of A/S at J/S_{max} varies from 0.500 when $\theta = 0$ to 0.707 when $\theta = 90$ deg. This relatively small range gives a quick rule-of-thumb to check if a mechanism has been designed close to the maximum snap-action point.

Elongation of the spring, Eq (2) is based on the assumption that the spring is installed in its free length S with no initial elongation. For a spring with a free length E smaller than S, the total elongation in per cent when extended to the dead center position is:

$$e = 100[(S/E)(1 + J/S) - 1] \quad (18)$$

Relationship between ϕ and θ at the point of maximum snap-action for any value of θ is:

$$\theta = 2\varphi \quad (19)$$

This can be proved by substituting Eqs (9) and (11) into the trigonometric identy:

$$\cos 2\varphi = \cos^2\varphi - \sin^2\varphi \quad (20)$$

and comparing the resulting equation with one obtained by solving for cos θ in Eq (15). This relationship between the angles is another means of quickly evaluating a toggle mechanism.

Design Procedure

A toggle is usually designed to operate within certain space limitations. When the dimensions X and W as shown in Fig. 4 are known, the angle θ resulting in maximum snap-action can be determined as follows:

$$A\sin\theta = S\sin\varphi = W/2 \quad (21)$$

Substituting Eq (19) into Eq (21),

$$A\sin\theta = S\sin(\theta/2) = W/2 \quad (22)$$

From Fig. 4:

$$X = S\cos(\theta/2) + A - A\cos\theta \quad (23)$$

Substituting Eq (22) into Eq (23),

$$X = \frac{W\cos(\theta/2)}{2\sin(\theta/2)} + \frac{W}{2\sin\theta} - \frac{W\cos\theta}{2\sin\theta} \quad (24)$$

Converting to half-angle functions and simplifying,

$$X = W/[2\sin(\theta/2)\cos(\theta/2)] \quad (25)$$

Using the trigonometric identity,

$$\sin\theta = 2\sin(\theta/2)\cos(\theta/2) \quad (26)$$

Eq (25) becomes:

$$X = W/\sin\theta$$

or

$$\sin\theta = W/X \quad (27)$$

Solving for θ permits determination

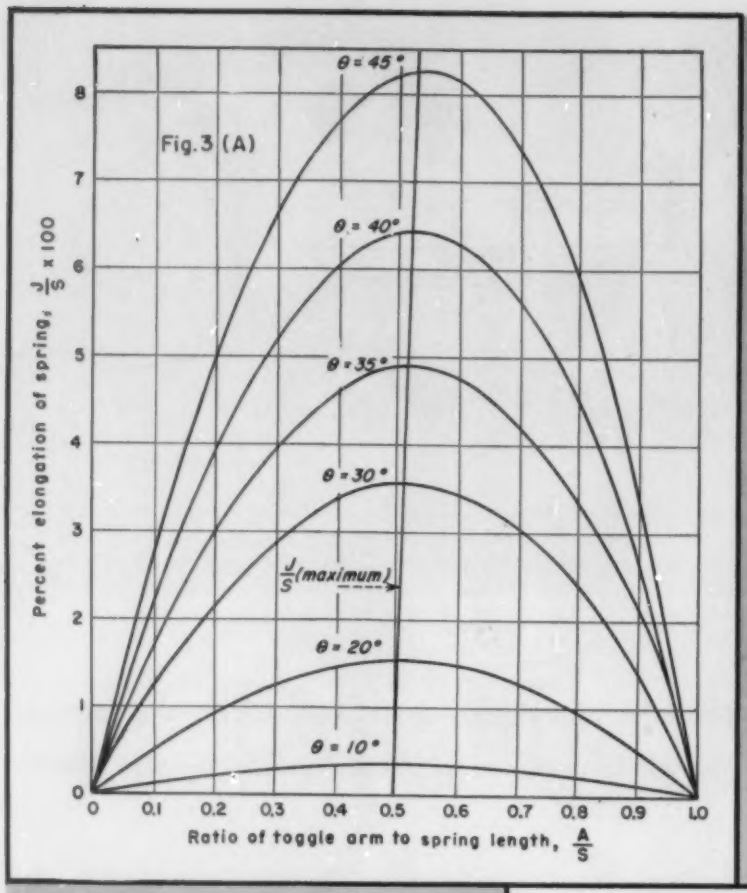


Fig. 3—Design charts for evaluating toggle arm and spring length for maximum spring elongation. Chart (B) is an extension of chart (A).

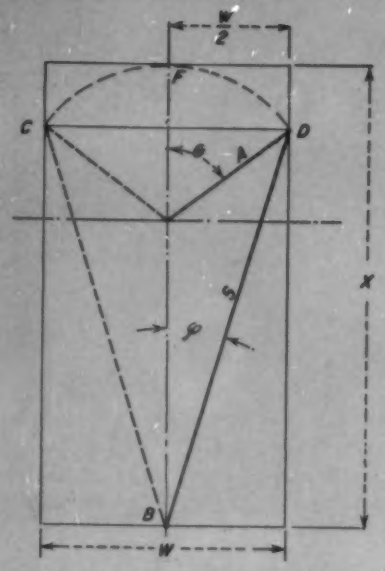
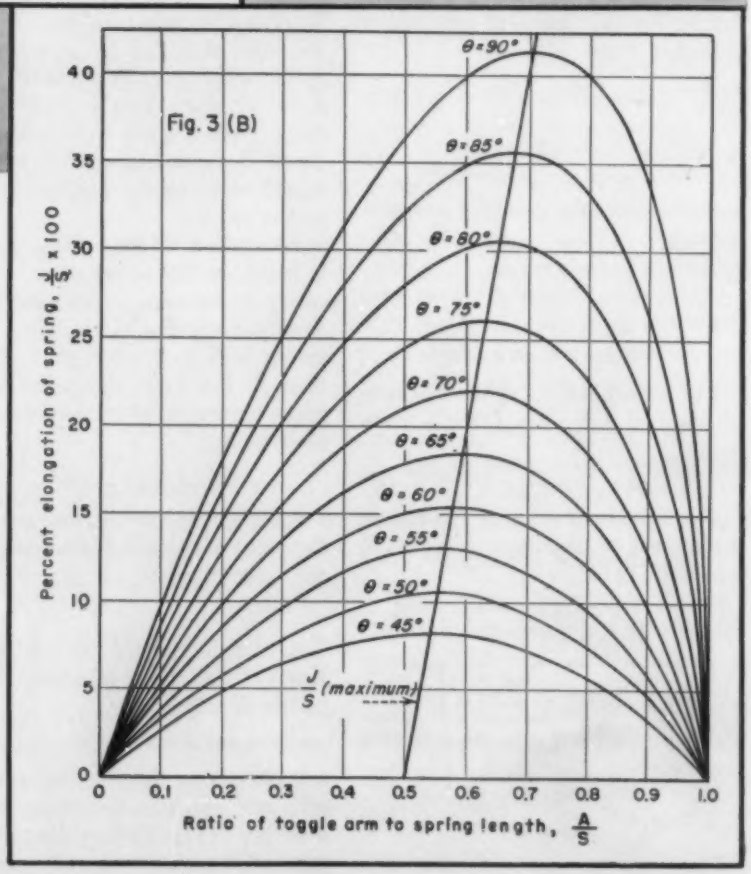


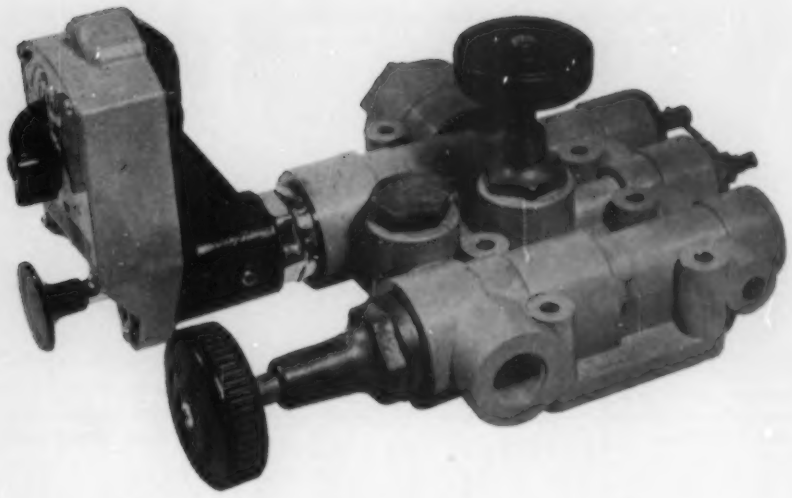
Fig. 4—Designing a toggle to lie within space boundaries W and X. It can be shown that for maximum snap-action, $\sin \theta = X/W$.

of ratios A/S and J/S from the charts in Fig. 3 when using the J/S(max) line. The values of S and A can then be obtained from Eq (22).

It can be seen from Fig. 3 that $\theta = 90$ deg results in maximum snap-action. Substitution of the sin of 90 deg in Eq (27) results in $W = X$; in other words, the most efficient space configuration for a toggle is a square.

EDITOR'S NOTE—In addition to the type discussed here, the term "toggle" is applied to a mechanism containing two links which line up in a straight line at one point of their motion giving a high mechanical advantage. A two-page mechanism spread, "Toggle Linkage Applications in Different Mechanisms" Thomas P. Goodman, appeared in the November 1949 issue of *Product Engineering*, p. 172, describing applications of this type to obtain: (1) high mechanical advantage, (2) high velocity ratio (3) variable mechanical advantage.





ONE-PIECE BODY has this Lindsay valve for a water softener is injection molded Kralastic type B; three chambers and horizontal and vertical openings are cored in.

KRALASTICS

A new series of thermoplastic materials combining high strength, toughness, and resistance to heat and corrosion.

EUGENE J. TRUNK,
Technical Service
Naugatuck Chemical Division, U. S. Rubber Company

NEW BLEND OF COPOLYMERS—styrene-acrylonitrile resin and butadiene-acrylonitrile rubber—produces a series of thermoplastic gum materials of high flexural strength and stiffness, high hardness and toughness, good chemical resistance and a high distortion temperature. The materials can be extruded, and injection and transfer molded. Five types with varying proportions of resin and rubber have been developed, each designed for specific applications.

Kralastic B has maximum toughness, and combines maximum impact with good chemical resistance and high heat resistance. It is the most difficult one of the series to injection mold, but this is not a problem in heavy-section parts such as pipe fittings and valve bodies where large runners and gates can be used. Because of its higher acrylonitrile content, this material generally has the best chemical resistance of the series.

Major applications for the type B material are for pipe valves and fittings. Other uses include extruded window or cabinet door slide tracks, various extruded shapes, screw driver handles and underground conduit. It resists corrosion conditions common in chemical equipment, plating and pulp machinery.

Kralastic D is a medium impact material with the highest hardness and heat distortion temperature of the series, and is intended for uses where these qualities are more important than impact strength. It has fair to good injection molding flow characteristics. Major uses to date have been in tool handles and camera parts.

Kralastic F material has properties intermediate between types B and D. It approaches type B in toughness and hardness, while sharing the good injection flow of type D. It is intended for more intricate molded shapes where ease of flow is important. The largest uses to date have been in such parts as lawn mower wheels, mine sweep cable floats, textile bobbins, and various housings and boxes, light duty gears, water meter housings, and refrigerator parts.

Kralastic H (recently designated Kralac) is a straight resin material with the maximum heat and chemical resistance of any material in the series. It is intended for molded or extruded items where only moderate impact is required. Ease of injection is between types B and F. Present and potential uses are in such parts as auto windshield wipers, washing machine parts and hot water tank dip tubes.

Kralastic J is a special blend which combines toughness, rigidity and good moldability. It has good toughness and high impact at temperatures as low as −40 F. Type J has the best injection flow rate of the series. Principal uses are for refrigerator parts and antenna brackets. Potential uses could be found in such items as battery boxes, suitcases, housings and pipe.

Mechanical properties of the five grades, listed in Table I, show relatively high impact strength, high hardness and flexural strength. Note that the all-resin material, type H, has the highest modulus, strength and heat resistance, but the lowest impact strength. Also, thermal expansion

Table I—Physical and Mechanical Properties

	H	D	B	F	J
Specific Gravity	1.08	1.05	1.06	1.04	1.02
Thermal Expansion, in. × 10^{-5}	3.6	4.7	5.6	5.6	7.3
Heat Distortion, 264 psi	208	193	187	185	172
Hardness, Rockwell R	122	108	96	92	62
Modulus × 10^5					
Compression	0.65	0.43	0.29	0.28	0.19
Bending	0.51	0.39	0.26	0.25	0.17
Strength, × 1,000 psi					
Compression	15.0	9.0	6.4	5.8	4.0
Bending	16.0	11.5	8.0	7.5	4.0
Tension	9.2	6.0	5.0	4.5	3.0
Impact, Izod ft-lb					
73 F	0.3–0.5	0.4–1.3	5–9	3–6	6–7
32 F	0.4	0.4	1.8	1.5	5–6
−40 F	0.6	0.4	0.6	0.4	2–3
Charpy, unnotched, ft-lb					
73 F	11–12	23–33	35–51	28–42	25–35

is the lowest for the group. Type J has the highest impact strength at low temperature (sub-zero) and lowest modulus and tensile strength, with the lowest heat distortion and highest thermal expansion. The other types range between these two extremes.

Thermal conductivity is 1.0 BTU/hr/ft²/deg F/in., and specific heat is 0.35 BTU/lb/deg F for all grades. Water absorption for all five materials is 0.2 to 0.3 per cent in 24 hr (ASTM D570-42).

As an indication of molding or extruding properties, the mobility range (ASTM D569-48) is 280 F for types D, F and J; 290 F for type H and 306 F for type B. Compression molding temperature for all grades is 325 to 375 F at a pressure of 1,000 psi; for injection molding, 350 to 600 F and 6,000 to 34,000 psi for all but type B for which the lower temperature is 375 F. Mold shrinkage averages 0.003 to 0.004 in. per in. Extruding temperature is 350 to 375 F for types D, F and J; and 400 to 450 F for types B and H.

Chemical resistance to acids and alkalies is excellent, and all grades are relatively unaffected when exposed to solutions of ammonium chloride, food acids, chlorine (wet or dry), castor oil, bleach solution, hydrogen peroxide (3 per cent max), kerosene, turpentine, and apcothinner. Table II shows the effect of a number of common chemicals on ⅛ x 1 x 3 in. specimens immersed for 7 days at room temperature in accordance with ASTM D543-43. Figures shown are for per cent change in weight.

Electrical properties are well above the average for plastics materials even with the all-resin composition for type H. Properties for the five materials are listed in Table III, with the types arranged in the same order as in earlier tables, (the all-resin compound listed first).

Molding and Extruding

All five grades are readily adapted to injection molding and extruding. However liberal production tolerances are required to allow for thermal expansion. While tighter tolerances can be held with closer production control,

LAWN MOWER WHEEL for Sears Roebuck power mower, molded by Ohio Plastics for Newark Stove Co., consists of two sections riveted together; material is Kralastic F.

normal tolerances on injection molded parts should be 0.004 in. on dimensions of 1 in. or under, plus 0.001 in. for each additional inch. For extrusions (pipe or tubing) tolerances should be about 0.005 in. for the first inch plus 0.002 in. for each additional inch.

Standard design practices may be followed for molds except:

1. Mold shrinkage is 0.003 to 0.004 in. per in.
2. Runners and gates should be 30 to 50 per cent larger in area; pinpoint gates can be used if sink marks pose no problem.
3. Center or disk gating should be used in mold cavities to eliminate weld lines.
4. Clamp pressure should be 3 to 3.5 tons per sq in. of mold projected area.

Standard injection molding machines may be used with the following practices:

1. Clamp pressures are near maximum.
2. Cylinder temperatures are 380 to 600 F, but should

Table II—Chemical Resistance

Change in weight in per cent for 7 days immersion at room temperature

	H	D	B	F	J
Water (distilled)	0.56	0.45	0.57	0.48	0.58
Hydrochloric acid, 10%	0.53	0.37	0.61	0.36	0.49
Hydrochloric acid, 38%	0.57	1.07	1.41	1.92	1.44
Sulphuric acid, 10%	0.53	0.42	0.56	0.30	0.47
Sulphuric acid, 45%	0.26	0.12	−0.01	0.02	0.10
Phosphoric acid, 85%	−0.25	−1.32	−0.05	−0.03	0.03
Nitric acid, 10%	0.48	0.46	0.57	0.53	0.52
Caustic soda, 10%	0.38	0.39	0.48	0.27	0.22
Caustic soda, 50%	−0.24	−0.01	−0.03	−0.03	−0.01
Ammonium hydroxide, 28%	1.00	0.91	1.14	0.77	1.00
Sodium carbonate, 10%	0.48	0.45	0.57	0.37	0.45
Ferric sulphate, 10%	0.52	1.43	0.58	0.47	0.54
Gasoline	0.20	13.14	3.43	14.20	4.95

EXTRUDED KRALASTIC B PIPE is light in weight and corrosion resistant. An early application for the material was a 12-mile line carrying corrosive salt water from oil wells. Pipe joints are made by cementing couplings, using a Kralastic solvent-type cement. Under turbulent flow conditions, smooth inside walls substantially reduce pressure drop compared with steel pipe.

be kept as low as possible to prevent loss of material properties.

3. Mold temperatures of 150 to 185 F give best surface finish and highest heat distortion temperature.

Usual extrusion equipment and practices may be employed with emphasis on these points:

1. Compression ratio should be 3½ or 4 to 1, with constant pitch and shallow flight

2. Dies and pins should be chromium plated, with land lengths about equal to extruded diameter; die should be about 10 to 15 per cent oversize. In general, screens are not required, but one or two 20 or 40-mesh screens are sometimes used to assist homogenizing.

3. Cooling mandrels or multiple-ring sizing equipment work equally well

4. Die and extruder barrel temperatures are somewhat critical; too low a temperature produces a dull finish, while too much heat discolors and roughens the material.

One important application for the new material is in pipe, where the high strength gives resistance to creep under high internal pressure. While the largest use to date has been in oil fields handling both brine and crude oil, industrial uses are growing where corrosion is a factor.

Ability to withstand severe corrosive conditions is demonstrated by one 3-in. pipe installation carrying brine at 120 F and 20 psi which has operated for nearly two years without failure.

Light weight of these materials offers another advantage in piping. Where operating temperatures are within range, the new material shows a substantial reduction in weight for the same strength even when corrosion is not a factor. Also, under conditions of turbulent flow the resistance or pressure drop is only about half that of steel pipe.

Table III—Electrical Properties

	H	D	B	F	J
Resistivity, ohm/cm, $\times 10^{13}$ 73 F and 35 RH	10+	10+	1.8	1.10	0.54
Dielectric Strength volts/mil, D149-44	393	350	312	351	340
Dielectric Constant 60 cps	2.96	3.41	4.76	4.15	4.00
1×10^6 cps	2.87	3.20	3.78	3.61	4.05
Dissipation Factor 60 cps	0.006	0.009	0.021	0.015	0.011
1×10^6	0.008	0.017	0.026	0.026	0.018
Loss Factor 60 cps	0.016	0.030	0.101	0.062	0.043
1×10^6	0.022	0.053	0.099	0.094	0.072

Some Limitations

Maximum working temperatures are 170 to 205 F depending on the type. Materials are subject to attack by esters, chlorinated solvents, ketones and aromatic hydrocarbons. In comparison with metals, Kralastic has limitations for structural members where stiffness or minimum load deflection is needed, or where working stresses are high. Also, long exposure to sunlight causes some loss in impact strength and elongation, although black pigments help to reduce this type of aging.

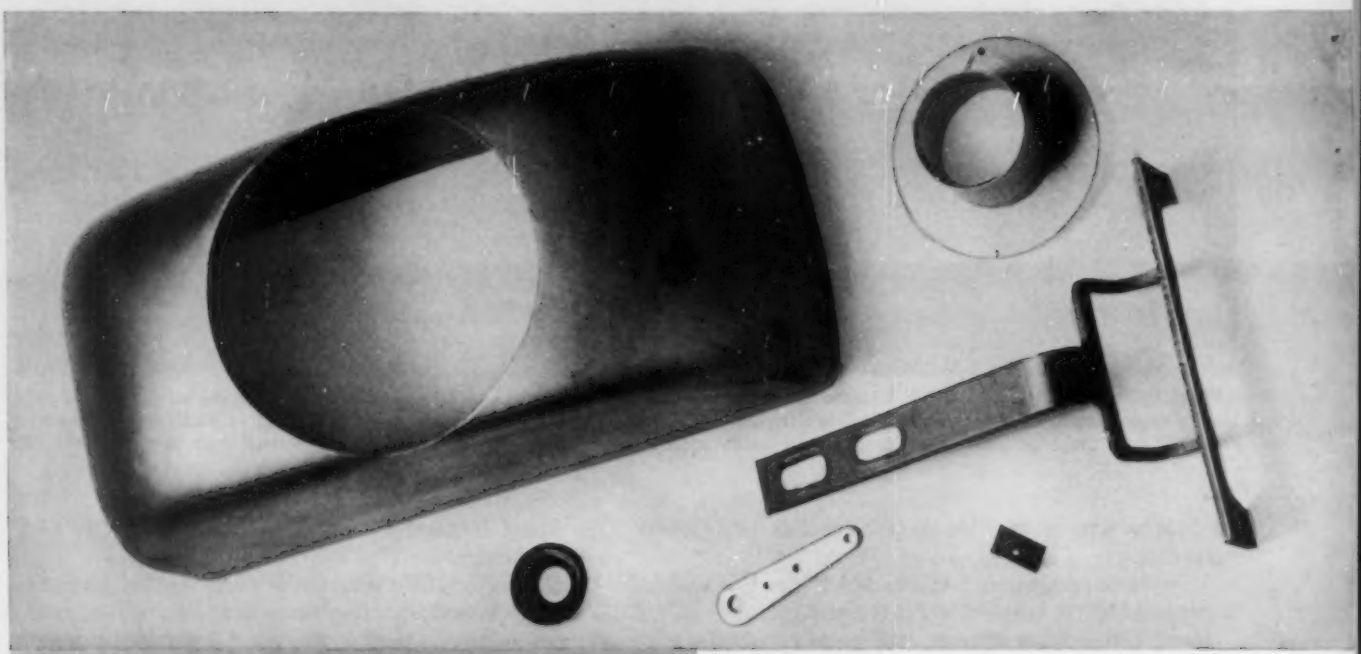
FOR FURTHER READING. Recent articles in this continuing evaluation of new plastics materials for structural uses have included:

"Fluorocarbon Plastics Today," October 1954 page 160; discusses differences between rigid and non-rigid types; mechanical chemical and electrical properties.

"Flexible Epoxy Plastics," September 1954 page 154; describes a new class of thermosetting plastics with high impact, chemical resistance and low shrinkage. "Vinyl Plastisols", January 1952 page 154; series of rubber-like materials with high electrical properties and resistance to oils and chemicals.

"Polyethylenes' Potential in Large Plastic Structures," April 1954 page 146; new fields of application as a welded structural material for light weight and corrosion resistance. Also, "Rigid Vinyl, a Structural Plastic," July 1952 page 160; application for a high strength material that can be fabricated by welding. "Advances in Reinforced Plastics," May 1954, page 165; properties of six types tabulated as a guide in material selection; methods of fabrication and design considerations.

Other related developments in plastics materials have been presented with physical properties and design data: "Fibrous Teflon—Another Engineering Material," December 1954 page 190; complete property data for this material in the form of woven fabrics. "Sintered Nylon Plastics," November 1954 page 150; includes comparison with sintered powdered bronze and injection molded nylon. "Properties and Characteristics of Foamed Plastic Materials," April 1953 page 166; data on five basic types. Also, earlier article "Foamed Plastics as Engineering Materials," April 1952 page 192.



Short-Run Stampings

For experimental parts, pilot runs, low production or emergency delivery.

How short-run stamping differs from usual tooling; size, shape and material limitations; 12 design tips for reducing piece cost.

DAYTON A. ROGERS
Dayton Rogers Manufacturing Company

SHORT-RUN PRODUCTION METHODS of stamping are applicable in general to any size or shape of part which can be blanked, pierced, formed and drawn to shape from any material. But, short run methods are particularly suitable and economical for parts needed in experimental and development work, or where needed in limited quantities (100 to 10,000 approximately), where changes or improvements in design are anticipated during production, or when a minimum "design to production" time is required.

Although a quantity from 100 to 10,000 is usually considered in the shortrun range, occasionally as few as 10 pieces are practical to stamp using special short-run methods. Often, too, more than 10,000 parts can be obtained from "short-run" dies at lower cost than with permanent tooling, particularly when low tensile non-abrasive material is used. The lower cost of short-run dies often results from the use of "softer" materials and easier means of fabricating. It is a good plan to have a job priced both by a short-run stamping house and a high-production stamping vendor when quantities are in the 10,000-20,000 range. Depending on the design, costs could be less one way than the other.

How Short-Run Stamping Is Different

The stamping process has always been a high-production method of fabrication. That it is also possible to stamp relatively small quantities of parts economically has not been so well understood. To do so, however, requires somewhat different setup and production techniques as well as different tooling considerations. Therefore, short-run stamping is a speciality usually done in shops separate from high-production stamping.

Presses used are often the same, but fancy and expensive jigging and automatic feed devices are usually avoided, while universal die plates with interchangeable and adjustable inserts are ingeniously used to cut setup time. In

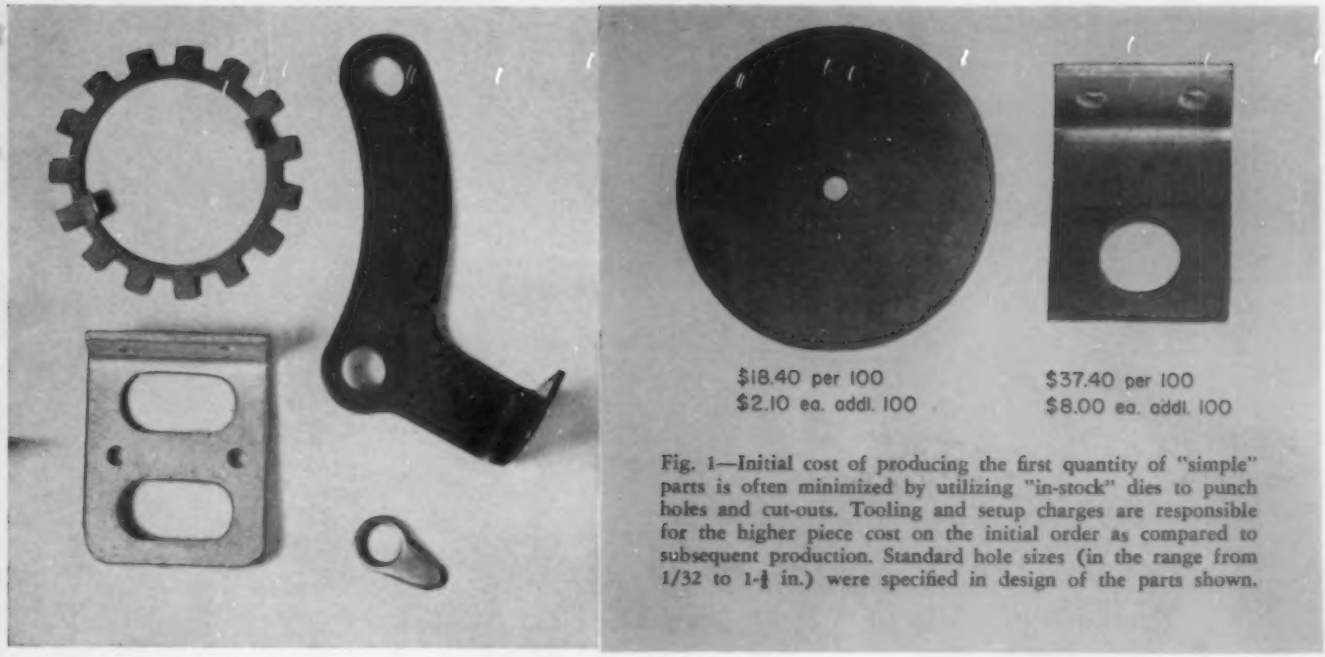


Fig. 1—Initial cost of producing the first quantity of "simple" parts is often minimized by utilizing "in-stock" dies to punch holes and cut-outs. Tooling and setup charges are responsible for the higher piece cost on the initial order as compared to subsequent production. Standard hole sizes (in the range from 1/32 to 1-¼ in.) were specified in design of the parts shown.

many short-run houses, a large inventory of stock fixtures, holders, punches and dies is maintained to keep tooling charges at a minimum. Much more ingenuity is required in laying out the job for efficient production and more operator skill is usually needed than in high-production stamping. Sometimes use of ingenious gimmicks make possible a lower price per finished piece, quicker delivery or higher accuracy.

Dies may be made of almost any material depending on material and shape being fabricated, quantity required and tolerances to be held. Wood or plastic tooling as well as steel is employed; irregular shapes may be nibbled out with "in stock" dies using two or more strokes of the press just to avoid making an expensive die. The "unconventional" stamping techniques and thinking employed for short-run production are greatly responsible for the flexibility that results and allows changes in design to be reflected quickly into the finished part at low cost.

Making Design Prototypes by Stamping

When a part is designed for production by stamping, prototypes are often made by such means as machining from solid stock, sawing out and filing sheet stock, or building up complex parts by welding or brazing together several less complex shapes. These crude methods of producing samples for design evaluation are resorted to in order to avoid the high cost of remaking the permanent tools in case of a design change. Yet, such makeshift methods of prototype fabrication have much to be desired; they do not reflect production factors which may cause trouble when tooling up for full production.

Short-run stamping techniques can produce prototype stampings equivalent in every respect to the final production stamping at 15 to 20 per cent of the cost of permanent tooling. Also, revised samples can be obtained quickly, at negligible cost, when design changes are made during prototype evaluation. When the design is finally "frozen," a trial run of from 100 to 10,000 parts can be produced from the short-run tooling to prove out the design before investing in the permanent tools and going into high-production stamping.

Size, Shape and Materials Limitations

Limitations on size and shape of stamping obtainable by short-run methods depends almost entirely on equipment available in a given vendor's plant. For instance, the maximum blank size that can be handled at Dayton Rogers is 20 x 20 in.; and although material thicknesses from 0.001 in. to ⅜ in. can be handled, 0.010 in. to $\frac{1}{16}$ in. stock is most economical to fabricate. The largest press is 225 tons and the maximum draw obtainable is 4½ in. Round holes can be economically pierced with stock punches and dies in sizes from $\frac{3}{32}$ to 1⅜ in. in steps of 0.001 in. This is particularly advantageous for simple fabrications like those shown in Fig. 1.

All material can be stamped by short-run methods that can be stamped with permanent high-production tooling. It is generally more economical to specify materials available in stock at the vendor. At Dayton Rogers Mfg. Co., an inventory of ¾ million lb of stock materials including aluminum (2S, 3S, 52S, 24S, 61S), brass (yellow and cartridge) phosphor bronze, copper (plain and beryllium), chromalloy (aircraft quality), laminated phenolics, monel, nickel silver, stainless steel (302, 410, 430), and cold-rolled steel (sheet and strip and all tempers). Also available is material with special thickness tolerances which are ½ of mill standards. All commercial stamping tolerances can be held without special effort. Close tolerances and odd shapes will bring about a higher tooling charge as is also true with permanent tooling. In Fig. 2, some of the more complex shapes are shown which require new tooling and where stock dies can be used for only a portion of the fabricating operations, if at all.

One of the primary advantages of short-run stamping

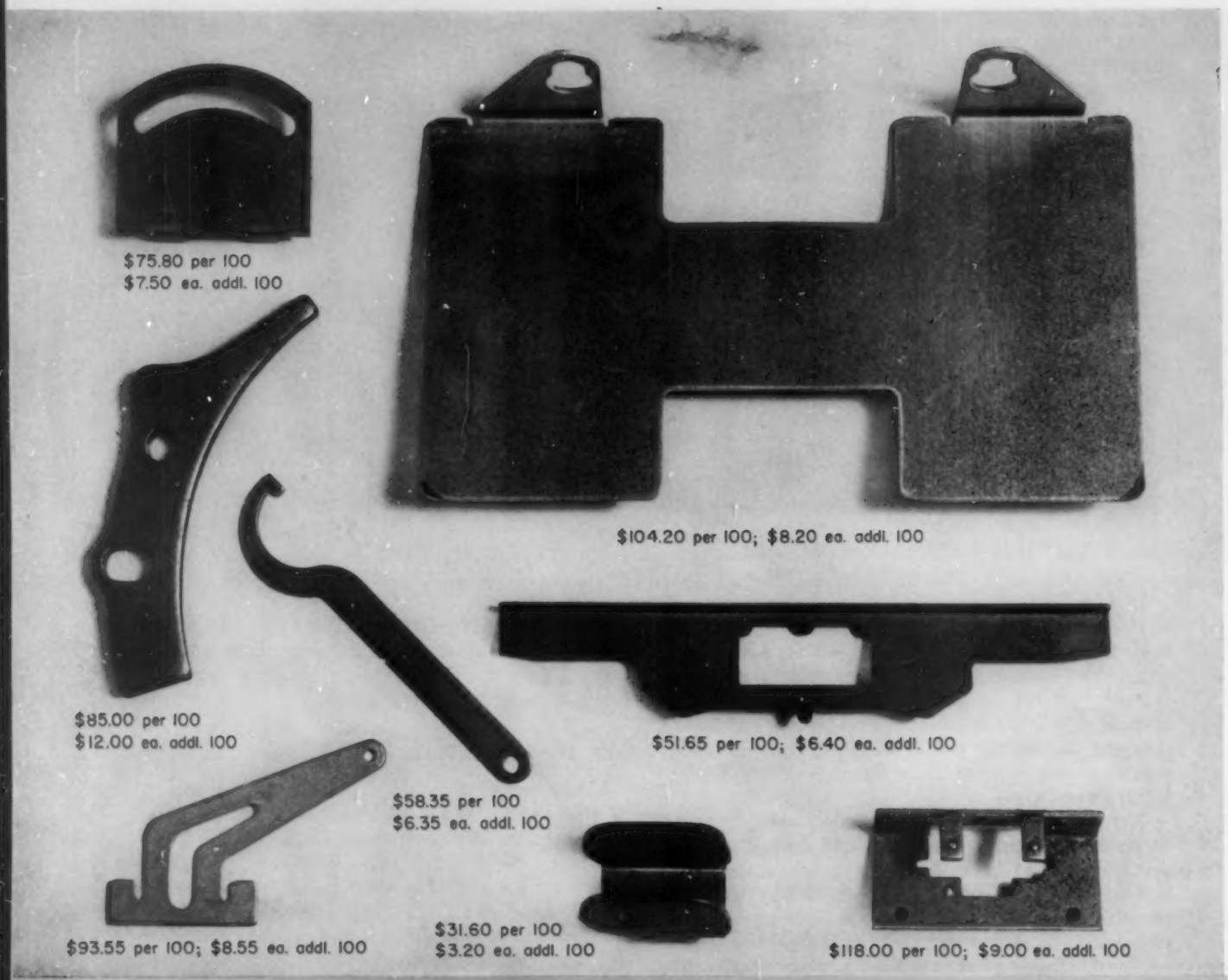


Fig. 2—Initial piece cost of these parts included a rather large tool charge because no "stock" dies were available and special dies had to be fabricated. Where the initial charge for the first 100 is relatively high, due to die costs, subsequent piece prices are often only a fraction of the initial charge because the special dies reduce the number of operations and thus cut labor cost.

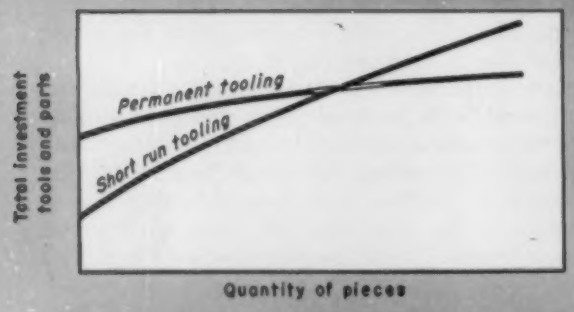


Fig. 3—As shown by this typical curve, there is a production quantity in most any stamping operation below which it is more economical to employ low-cost, short-run tooling and production methods and above which more costly production dies and high-production methods will give lower piece costs. When quantities of 10,000 to 25,000 are involved, it will usually pay to get quotations from both short-run and high-production vendors.

methods is the quick tooling which shortens the cycle from design conception to production of a part. From the time an order is placed for short-run stampings, accompanied by complete drawings, stampings can be in production in from 3 to 6 weeks average, depending on complexity, material used, and tolerances required.

Pricing

Pricing of short-run stampings is based on four factors: tool and die charge; setup charge; production time labor

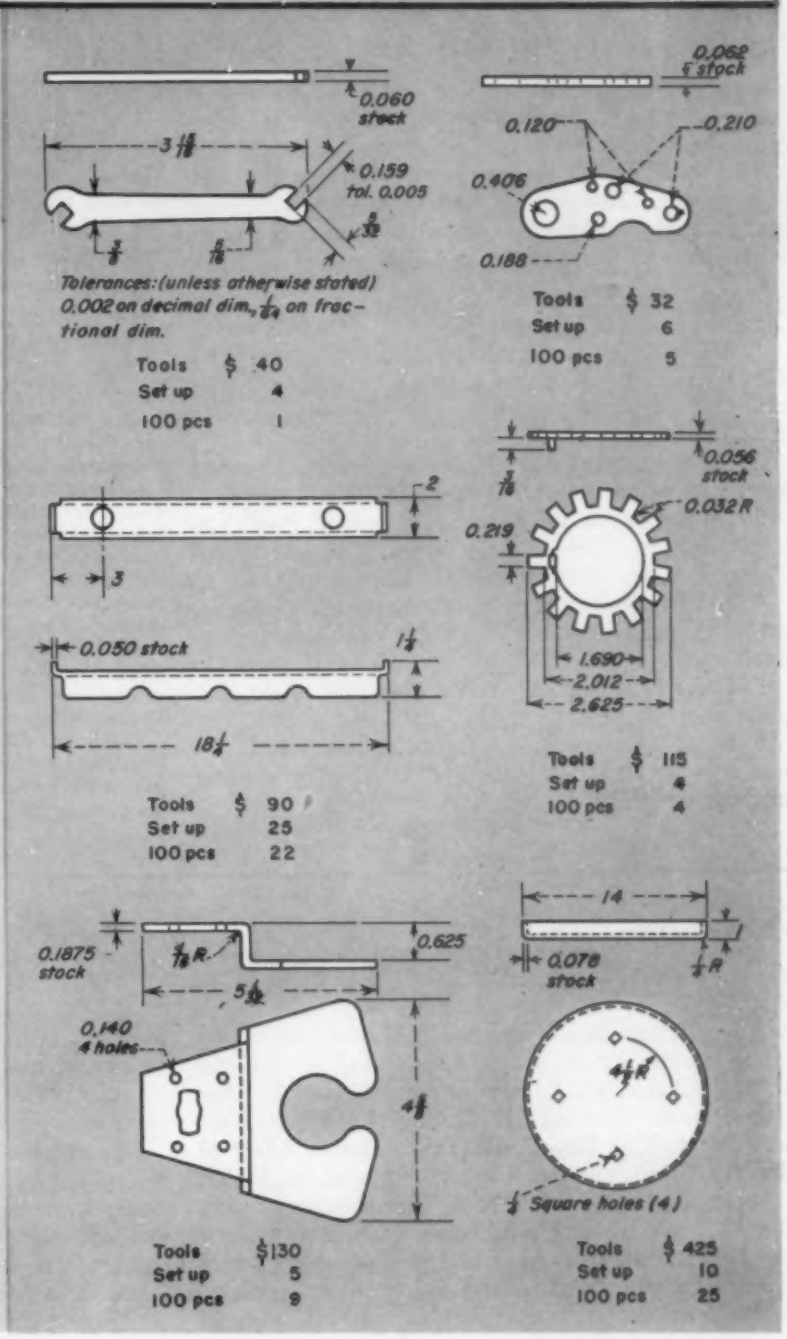
Tooling, Setup and Production Costs for Representative Short-Run Stampings

Tool cost, as given for each example, is charged only on the initial production order and is not incurred in repeat orders since dies are retained until customer approves scrapping them. Set-up charges, however, are involved each time an order is entered or placed in production. Price per 100 is a measure of the production labor cost which is determined by the tooling employed as well as the number and kind of operations used to make the part. Since the material of which the part is made ordinarily does not greatly influence these costs, material cost has been omitted from these examples.

Figures shown for tooling, setup and running costs per 100 pieces (but excluding material cost) are typical and can give a general idea of expected costs; yet considerable variance from these costs is possible depending on local conditions—such as: the sizes of presses available on which to run a job, the delivery required, available labor, how many jobs are in the house, tolerances specified, material type and thickness, what dies are in stock, and special machines available for given operations.

Stock dies, which differ from vendor to vendor, determine the setup time and operations necessary for producing a specific part. Also, special tools may be considered to cut out some steps in fabrication. Complexity of tooling will be based in part on quantities involved and whether saving in labor will offset added tool cost. Or, delivery time may be so important that available labor can't handle the order unless steps in fabricating are reduced to a minimum; this often involves additional tooling and greater cost. Then again, if usual tooling is so complex that it takes too long to make, but labor and machines are available to handle multiple operations, an emergency order may be handled with less tooling but with more labor for setup, nibbling and hand work.

Therefore, costs shown by these examples are intended only as a guide rather than as the basis for a pricing formula.



charge; material cost. Usually the most important factors are tooling and running costs which depend on quantity anticipated. The variables over which the designer has some control are: (1) tool and die charge (based on such factors as tolerances specified, complexity of the part, hardness of material, or depth of draw required; (2) production time (dependent on how many different operations are required to shape up the part).

Typical parts produced by short-run stamping methods are shown in Figs. 1 and 2, together with pricing data. The die charge is usually amortized over the first 100 pieces. From then on all die maintenance costs are absorbed by the vendor. A few pieces of a complicated shape can sometimes be obtained using stock dies and nibbling or forming in a series of relatively time-consuming operations. Where more than a few such pieces are needed, however, it usually becomes cheaper to make special tools.

In Fig. 3, a representative curve shows how quantity of production has a direct bearing on whether to use a short-run stamping vendor or a regular high-production stamping house. When the quantities involved approach 10,000 or more, it is best to get quotations from both types

of vendors and compare, giving due consideration to such problems of initial production as delivery time and design changes that may be required during the pilot run.

How to Minimize Stamping Costs

It is always a good rule not to include on the design specification any tolerance or limitation on forming for which one is not willing to pay. High tolerances, tight corners, and "round" holes, all cost more than less rigid requirements. However, in short-run work these factors are generally much more important in determining costs than with permanent tooling for high production.

Tips To Cut Costs

1. Do not specify a close standard tolerance for all dimensions of a part if only certain dimensions must be held to this tolerance. Open up all tolerances as much as possible.
2. Do not specify cold rolled strip steel if cold rolled sheet steel or hot rolled pickled and oiled will do.
3. Do not specify any heavier gage material than absolutely necessary. Heavier gages cost more to handle and shorten die life; also, material cost is more.
4. If burr removal is unimportant, do not specify it. An extra operation can be avoided with lower costs resulting.
5. Order in maximum possible quantities to get best piece price.
6. Specify the production quantity anticipated. In this way the cheapest short-run tooling and production methods can be used.
7. Do not specify a definite sequence of operations without first discussing the matter with the supplier. Tell the supplier the results wanted and let him accomplish it his way.
8. Avoid long, narrow sections along blank contour, relative to material thickness and shear strength.
9. Avoid small holes too close to the edge relative to material thickness and shear strength.
10. When close tolerances are specified on hole sizes, indicate whether holes are to be punched holes for fastening or reamed holes for bearing surfaces.
11. Allow sufficient relief (beyond inside bend radius) around forms when bends are close to blank periphery.
12. Designate blank and hole location dimensions in linear measurements instead of angular.

EDITOR'S NOTE—Supplementary information may be found in two previously published articles. One in *Product Engineering;* the other in the *Product Engineering Annual Handbook of Product Design for 1954.*

On page 162 of *Product Engineering* for January 1952, "Basic Design for Small Parts Stampings" gives ideas for design of relief notches for right angle bends and location of pierced holes relative to these bends.

"Designing Stampings for Economy," on page D6 of the 1954 *Product Engineering Annual Handbook* issue gives tips on draw design, nesting to minimize scrap, edge design, notching, bead forming, flanging, radii considerations, hole location data and other design considerations. Tables of standard sheet thicknesses and tolerances are included for ferrous and non-ferrous metals together with tips for reducing costs of sheet metal fabrication.

The factors discussed in these articles are applicable to both short-run and high production stamping; yet, for short-run they take on added significance because of possible higher cost per piece.

Problems of Standardization Programs

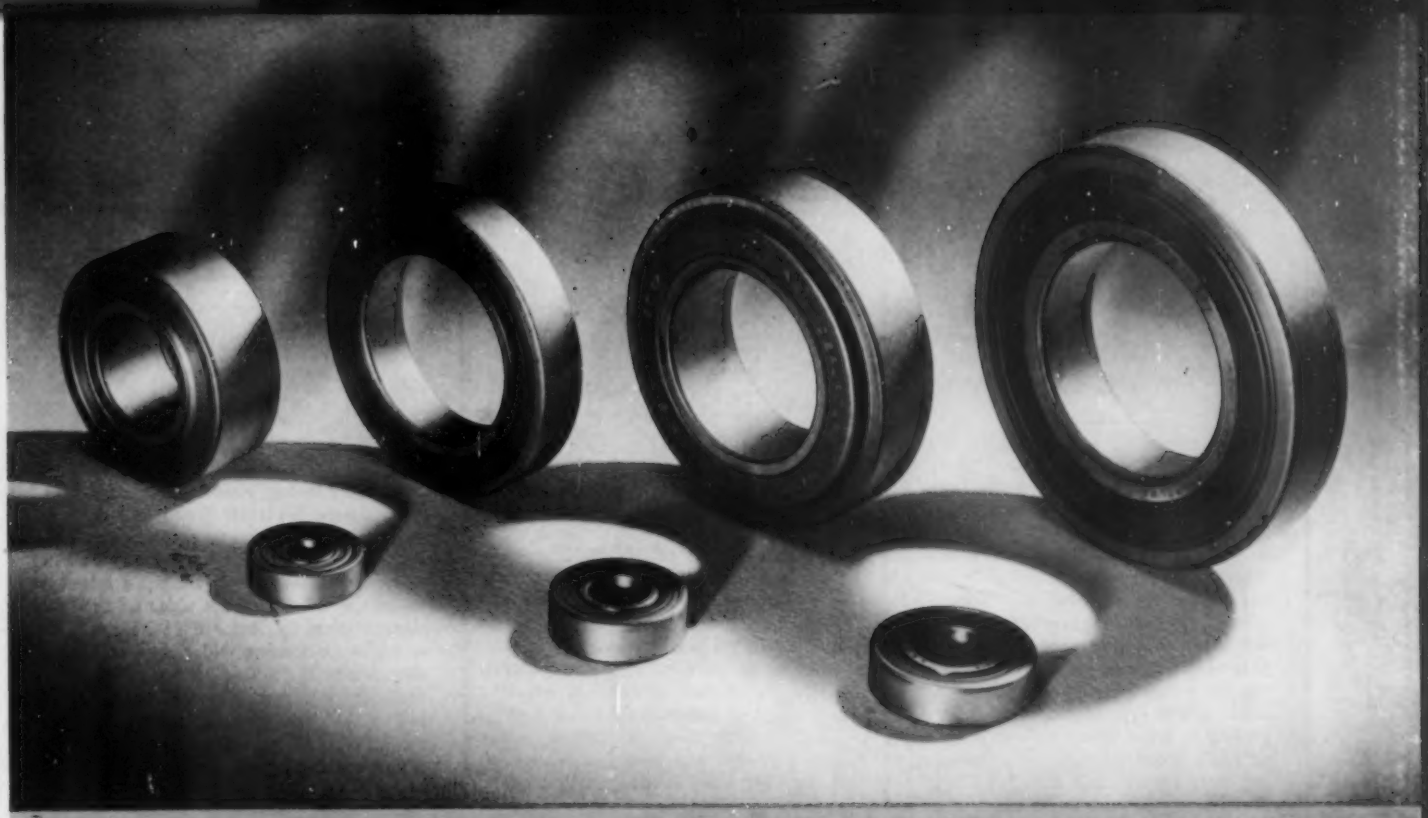
The Department of Defense has its standardization program, Industry has its standardization, and so does the U. S. Air Force. "But however different the objectives may seem, the three are not working at cross-purposes," according to Col. Roy C. Heflebower, former Chief of the Air Standardization Group, Headquarters USAF. However, he did say that a better understanding of what the Air Force is doing is of considerable importance if the Department of Defense and industry are to help them when problems arise that are of mutual concern. International military standardization deals with material and materials; but in addition, operations, administration, logistics, definition of words, common doctrine of air defense language, statistical services, and many others.

The problem of arranging complete international standardization with countries regarded as U. S. allies is a huge job, and not one to be handled by the Air Force alone. Successful accomplishment requires all that has gone into the industrial standardization, and all that is planned for the Department of Defense program—all of which is complicated by opposed national interests, diverse national standards, competition, and vested private interests.

What the Air Force is trying to do is to provide a capability for the Allied Air Forces to work together in combined operations, and reduce the technical obstacles which prevent this. This includes everything from hydraulic fluids, oils, electric power, and materials, to operational problems.

In connection with this, there are certain things which are avoided by the Air Force. (1) Trade secrets are not divulged, nor is the area of patent and proprietary rights invaded. If manufacture is undertaken by a foreign country, it is only done so after proper licensing arrange ments have been made with the U. S. manufacturer. (2) Unnecessary costs and burdens on the U. S. government or U. S. manufacturers are avoided. Before any international standard is entered into, every consideration is given to the effect on U. S. industry. (3) The Air Force is not trying to cramp design and development initiative. This accusation is frequently made of not only the domestic program of which all manufacturers are a part, but of the international program as well.

In the material field, international military standardization at times is almost impossible. Col. Heflebower says, "Barriers to progress are great. Industry is interested in profit, and if dollar benefits cannot be shown, standardization measures have little appeal. This is basically true in the Department of Defense program."



How to select the combination of bearing and seal for maximum life and performance. Types of seals, seal materials, effect of temperature and speed, and suggestions for design of equipment.

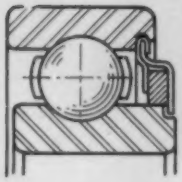
CARTER T. BRAGDON and MICHAEL T. MONICH
New Departure Div., General Motors Corporation

GREASED-FOR-LIFE BALL BEARINGS often simplify an assembly by reducing the number of parts required, reduce maintenance costs by eliminating the need for relubrication, and save space and weight. However, the seals—which serve both to exclude foreign matter and to retain lubricant—must be chosen with just as much care as the bearing itself.

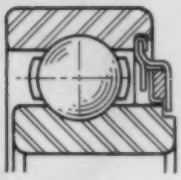
No one design is equally efficient for all operating conditions, particularly over a range of speeds. The type of lubricant, type of contaminant to be excluded, operating temperatures, mounting position and desired life all play an important part in determining which seal design is best for a given application.

In Table I, integral type ball bearing closures are divided into two classes: contact, and clearance type. With contact seals there is a definite pressure between the stationary and rotating parts. Control of this pressure is important since it determines the amount of sliding friction, which, in turn, governs the maximum speed that can be attained without execcsive heating. Even with the softest material available, an excessive pressure can result

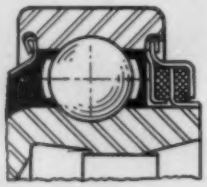
Table I—Typical Ball Bearing Closures of the Integral Type



A Felt Rubbing Type Seal: General purpose seal for grease lubricated bearings. Felt ring is held in place by two shield members which are permanently fixed in an outer ring groove. Sealing is accomplished by rubbing contact of the felt washer with the smooth OD surface of the inner ring. By controlling the felt washer dimensions, it can be made either tight fitting for efficient sealing or loose fitting for low torque or high speed performance. Operating temperature limited to 275 F and limiting speed to 3000 inner ring fpm for standard fit-up.

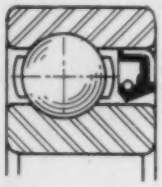


B Felt Rubbing-Layrinth Seal: Intended for operating conditions more severe than that for which the plain felt rubbing seal is suitable. Although similar to the felt rubbing type, its construction further incorporates the use of a retaining slinger ring which carries the felt washer in side-wiping contact with the outer shield. As illustrated, this suppementary member creates a labyrinth path which further bars the passage of both lubricant and foreign materials. Sealing efficiency is the principal advantage of this design while its limitations are lowered limiting speed and limitations due to the properties of the felt material used. This seal has found extensive use in the automotive rear wheel application.

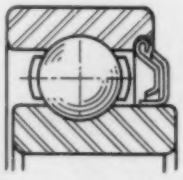


C Double Felt Rubbing Seal: Designed for slow speed and extremely severe operating conditions. In construction, it is similar to the felt rubbing-labyrinth type but a felt washer is used on both sides of the slinger member. Because of its construction, a bearing wider than standard width is required. Since a tight fit-up is required, limiting speed is lower than for the previously discussed types. Used primarily for conveyor bearing applications.

E Fixed, Notch Rubbing Type Seal: General purpose, narrow width seal similar in principle to (D) except that the sealing member is generally a stamped rubber diaphragm held in place by a metal shield member. Although external surface is all metal, provision is often made for relubrication by means of small holes punched in the metal member to permit injecting additional lubricant into the bearing. Speed and temperature limits are governed by the properties of the material.



F Spring Lip Type Seal: Suitable for bearings exposed to severe —fluid as well as dry—contaminating conditions. Also are often used to retard oil flow. As shown, the effectiveness of this construction depends upon the radial pressure exerted by the seal lip upon the smooth OD surface of the inner ring. Often this is accomplished by a supplementary spring member. Principal limitation lies in the fact that bearings wider than standard are often necessary. Further, heavy seal pressure often reduces the top limiting speed.

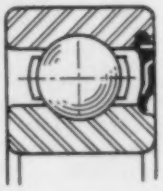


G Metal Slinger Labyrinth Type Seal: Used in applications requiring low torque, high temperature or high speed characteristics. Consists of two members; one rigidly fastened to the outer ring and the other fastened to the inner ring with suitable running clearances between seal elements. Does not have the efficiency of previously discussed seals so far as exclusion of fluids is concerned, but is very efficient against dry contaminants at relatively high speeds. Temperature limitations applying to rubber or felt materials do not exist.

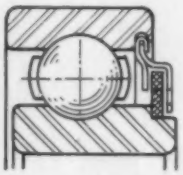
in a damaged or charred seal, or in a scored or burned bearing ring. Also, rubbing seals require a smooth rotating surface to minimize wear and friction and to maintain constant drag. Similarly, this surface must be free of secondary motions such as eccentricity and face runout.

Clearance or noncontacting type closures, which also include supplementary devices such as slingers and deflectors, are used primarily at high speeds where minimum friction is required. The simplest type, Fig. 1 (A), consists of one member fixed in the bearing outer ring with a minimum clearance between the seal bore and the inner ring OD. It is not a true seal and is generally referred to as a shield or plate. Metal shields are used to assure an adequate supply of grease in the bearing and are more effective in excluding coarse grit or metal chips than fine abrasive matter. They are not recommended for fluids.

With clearance-type seals, the length of the passage between sealing members determines its efficiency in retaining lubricant and excluding dirt. When a tortuous instead of a straight path is used to minimize width,



D Removable, Notch Rubbing Type Seal: High efficiency, universal-purpose design. Consists of a molded synthetic rubber sealing member held in position by engaging the groove in the bearing outer ring. Sealing is accomplished by light contact pressure between the seal bore and a ground recess on the inner ring of the bearing. Principal advantages are that it can be readily removed and reassembled for regreasing. Also can be relubricated by means of an injection needle. Limiting speed is approximately 2500 seal rubbing fpm. Limiting temperature is determined by material — about 250 F for Buna-N.



H Felt Slinger Labyrinth Seal: Created primarily for low torque at high speeds, fair sealing ability and provision for relubrication. Constructed of two members rigidly fastened to the outer ring between which a felt slinger pressed on the inner ring OD is located. Avoids direct felt rubbing contact and permits high speed operation. Can be relubricated with an injection needle stuck through the felt. Temperature limit is 275 F. For higher temperatures steel slinger can be used.

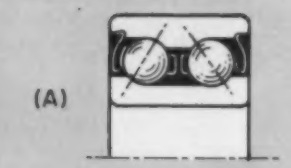
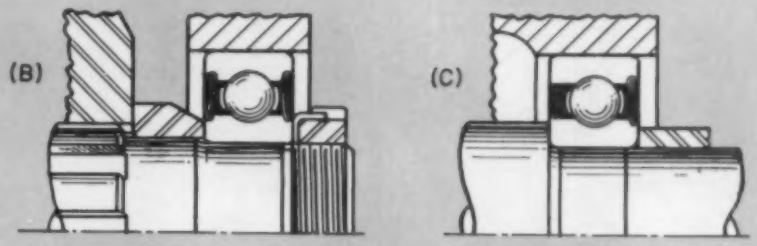


Fig. 1—Simplest form of clearance seal (A) consists of one member fixed in bearing outer ring with minimum clearance between seal bore and inner ring OD. In (B) is two-face contact type; (C) is a single-sealed bearing open on one side.



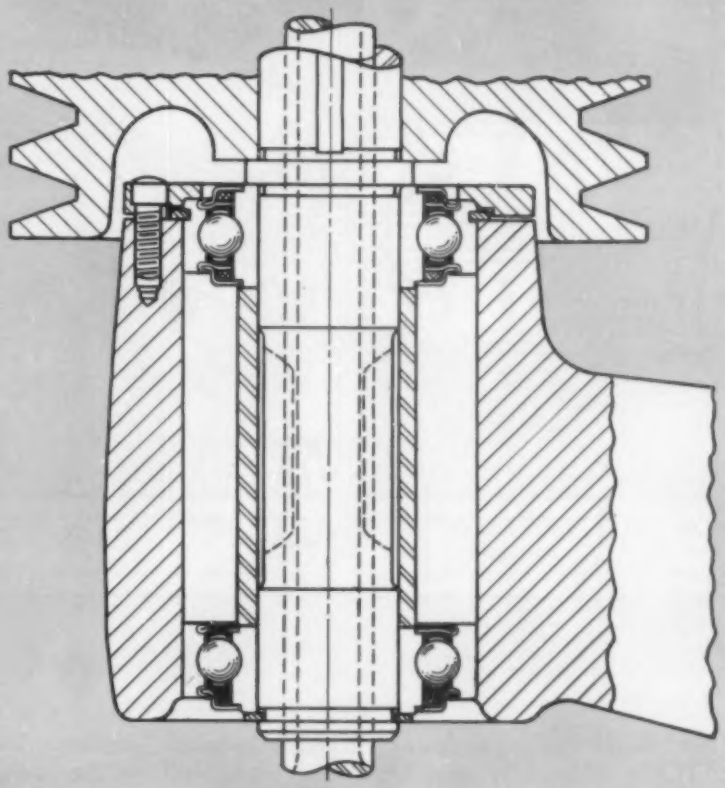


Fig. 2—Drilling machine application of integral seal bearings. Upper bearing has a double felt seal; lower bearing uses one seal and one shield.

these closures are referred to as labyrinth type, G and H of Table I. With such designs, radial clearances should be kept to a minimum without risking interference. On the other hand, axial clearances between stationary and rotating parts are larger to avoid a centrifugal pumping action by the revolving member. When operated at sufficient speeds, labyrinth seals are effective against abrasive contaminants, but as with the plain types, they are not recommended for fluids.

Selecting the general type of closure that should be used is largely determined by operating factors such as speed, temperature, type of lubricant and nature of contaminants to be excluded. Final details must be determined by the specific requirements of each application. In this way it is possible not only to achieve satisfactory performance, but also, it is often possible to simplify a design. For example, Fig. 2 shows a quill mounting for a light drilling machines. The upper bearing has a double felt seal, while the lower bearing uses one seal and one shield. The housing need only be bored straight through

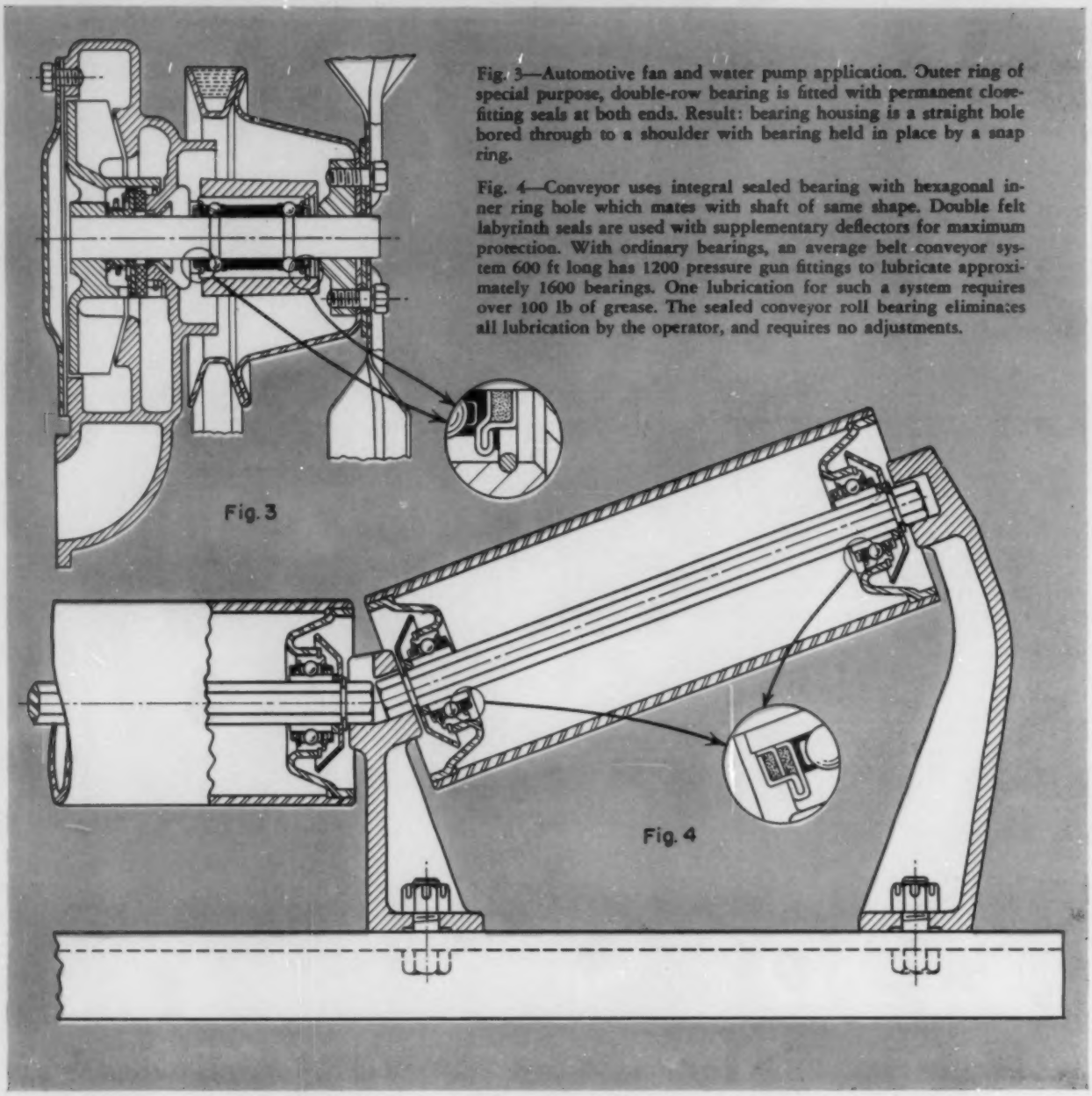


Fig. 3—Automotive fan and water pump application. Outer ring of special purpose, double-row bearing is fitted with permanent close-fitting seals at both ends. Result: bearing housing is a straight hole bored through to a shoulder with bearing held in place by a snap ring.

Fig. 4—Conveyor uses integral sealed bearing with hexagonal inner ring hole which mates with shaft of same shape. Double felt labyrinth seals are used with supplementary deflectors for maximum protection. With ordinary bearings, an average belt conveyor system 600 ft long has 1200 pressure gun fittings to lubricate approximately 1600 bearings. One lubrication for such a system requires over 100 lb of grease. The sealed conveyor roll bearing eliminates all lubrication by the operator, and requires no adjustments.

and faced on one end and no locating shoulders are necessary. This is achieved by using a snap-ring integral-seal bearing. Since, in general, single-row sealed bearings have a thrust capacity equal to their radial capacity, no supplementary devices are required to accommodate the loads encountered in this application. When necessary, it is possible to obtain integral-sealed bearings in better than standard precision grades, thus almost any degree of accuracy and smoothness can be obtained. Additional applications shown in Figs. 3-6 illustrate other advantages that may be obtained.

Materials

Felt has been used for years in integral closures and, in its improved forms, it is still one of the most satisfactory materials. The properties that make it useful are its resiliency, low friction, wear resistance and wiping action of the fibers. Also, it rapidly absorbs lubricant because of its porosity. However, this porosity renders the seal inefficient against gases and liquids unless it is specially treated.

Felt is impervious to the chemical action of most ball bearing lubricants and will withstand temperatures up to 275 F before charring. It can be obtained in two forms—woven and pressed. Because of its construction, woven felt is inherently strong and resistant to permanent distortion. Pressed felt, on the other hand, has poor dimensional qualities and requires extreme caution in handling. Both types can be used; woven felt is generally preferred for integral ball bearing seals because of its superior dimensional stability.

Synthetic rubber is nonporous, has low friction, low permanent set, is noncorrosive, nonabrasive and minimum

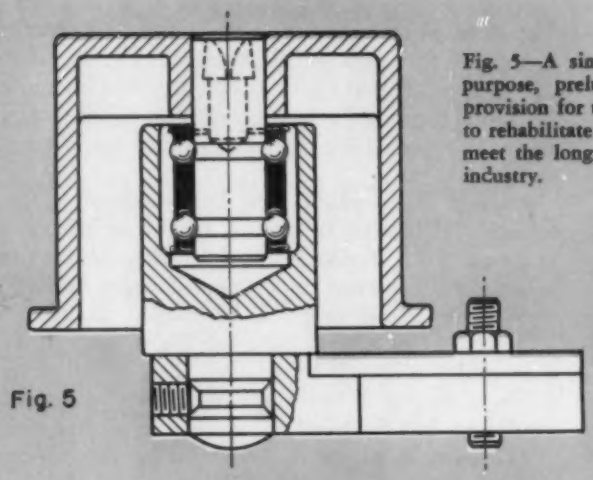


Fig. 5

Fig. 5—A simple method for mounting an idler pulley. A special-purpose, prelubricated, double-shielded, double-row bearing makes provision for the addition of a small quantity of oil at suitable periods to rehabilitate the original grease. Such an arrangement is necessary to meet the long life requirements common to such fields as the textile industry.

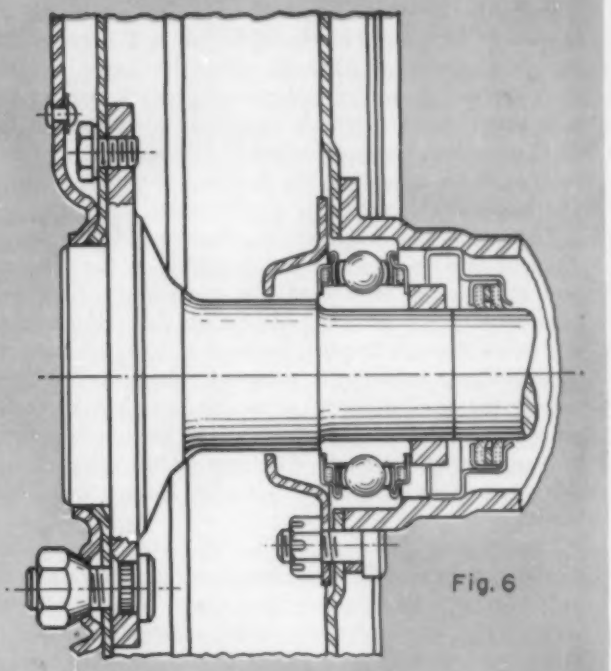


Fig. 6

Fig. 6—Probably the best known example of an integral sealed bearing is the automotive rear wheel bearing mounting. These bearings are lubricated for life with a special grease and are completely enclosed on both sides with permanent seals. As a result, abrasive foreign material is kept out of the bearings and grease is effectively retained. In the design illustrated, a supplementary shaft rubbing seal is required to keep the oil from adjacent mechanisms from infiltrating past the felt seal into the bearing. Recent designs using molded synthetic rubber sealing material integrally mounted with the bearing indicate that they will provide sufficient sealing to permit the elimination of the supplementary oil seal.

Table II—Relative Seal Efficiency

	Seal Type (Letters in left-hand column correspond to illustrations in Table I.)	Friction Characteristics	Grease Retention	Wet Contaminant Exclusion	Dry Contaminant Exclusion
A	Felt rubbing seal	Moderate	Good	Fair	Fair
B	Felt rubbing labyrinth seal	High	Excellent	Fair	Good
C	Double felt rubbing seal	High	Excellent	Fair	Excellent
D	Removable notch rubbing seal	Moderate	Excellent	Excellent	Excellent
E	Fixed notch rubbing seal	Moderate	Good	Fair	Good
F	Spring loaded lip seal	High	Excellent	Excellent	Excellent
G	Metal slinger labyrinth seal	Low	Good	Fair	Excellent at High Speeds
H	Felt slinger labyrinth seal	Low	Good	Fair	Good

volume change in most lubricants. Another important feature is its ability to be precision molded in small cross sections. This makes it directly applicable to ball bearing use since space is generally limited. Also, these rubbers can be bonded to metal which not only makes it possible to use metal inserts to control seal contact pressure, but also gives it sufficient retention in the bearing ring. In addition, when seals are fabricated from synthetic rubber, as shown in D of Table I, they cause negligible OD out-of roundness at assembly. This is extremely important in bearings requiring precision tolerances. However, aging, repeated flexing and plastic flow reduce the resiliency of synthetic rubber materials. Consequently, after a period of time a seal loses its original contact pressure and is less efficient. This condition is aggravated when there is eccentricity between the stationary and rotating member but can be reduced by close dimensional control of the bearing dimensions.

The synthetic rubber most commonly used in integral seals is Buna-N. This material can withstand temperatures

up to 225 F for continuous operation when exposed to diester, silicone and petroleum lubricants. For higher operation, a special polyacrylic rubber is available that can operate continuously at temperatures up to 350 F; however, it deteriorates rapidly when exposed to diester lubricants at this temperature.

Life of Sealed Bearings

Probably the most important factor leading to the development of sealed, lubricated-for-life ball bearings was the development of adequate grease lubricants. In the past, the quality and consistency of available greases was such that they were entirely unsuitable when used in the small quantities required for sealed ball bearings. Further, because of oil separation, the consistency within a particular batch would often vary considerably.

The useful life of grease is a function of the rate at which it oxidizes which is closely related to the temperature to which it is exposed. In general, there are two main sources of heat in a ball bearing: that self-generated as a result of grease and bearing friction, and that resulting from ambient conditions. Although the heat developed outside the bearing affects grease life less than heat self-generated by the bearings, particularly that resulting from bearing loading, high ambient temperatures often dictate the grease life which will be obtained from a sealed ball bearing.

Considerable data have been accumulated on various ball bearing lubricants, with particular attention to a high-melting-point sodium soap grease which is standard with a number of bearing manufacturers. The curve in Fig. 7 shows the relationship between grease life and bearing outer race temperature on a semilogarithmic plot. At 120 F a life of some 21,000 hr may be expected; however, at 250 F, the expected life is decreased by approximately 50 per cent.

Although the temperature is the primary concern when forecasting grease life, other factors—such as speed, load and special ambient conditions—are also important. For example, tests show that the indicated life obtained from Fig. 7, based on temperature alone, must be modified by a speed factor such as illustrated in Fig. 8. Thus, at 120 F, the indicated life of 21,000 hr would be multiplied by 0.75 if the speed were approximately 8,000 rpm. Likewise, the expected life must be modified for bearing load and size.

Another factor which must be considered is the distribution of bearing failures. A typical probability curve is shown in Fig. 9. As an example, when 50 per cent of average life is reached on a group of sealed bearings, approximately 10 per cent will have failed; likewise, when 100 per cent of average expected life is reached, 54 per cent of the units will have failed. This curve, of course, differs somewhat between various greases and operating conditions, but the trend is the same in all instances.

The chart in Fig. 9 is also useful for determining an optimum interval between relubrication. In this connection, it is generally recommended that a grease bearing be relubricated after a period representing 40 per cent of the expected grease life, although this procedure principally applies to removable or relubricated type seal bearings.

Types of Sealed Bearings

The most widely used bearing is the single row radial, often known as the Conrad or deep groove type. Because it is symmetrical and is capable of taking both radial and thrust loads in various combinations, this type of bearing is especially adaptable to use with integrally assembled seals.

In general, the need for extreme accuracy, rigidity and speed is not critical in most sealed applications and bearings built to the ABEC-1 tolerance grade are generally satisfactory. For example, washing machine motors or mechanisms should not have objectionable noise or vibration, yet the precision required of instrument applications is not generally warranted. Also, ABEC-1 bearings can be obtained with suitable refinements when one or more dimensions must be held to closer tolerances than

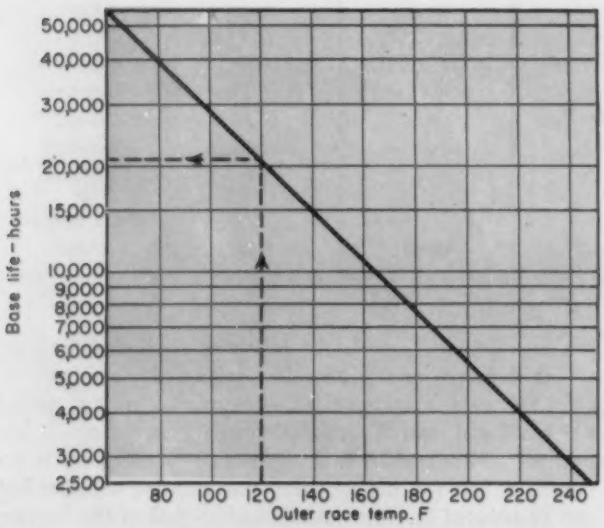


Fig. 7—Effect of temperature on grease life plays an important part in determining the performance of sealed bearings. Silicones are among the best high temperature greases now available.

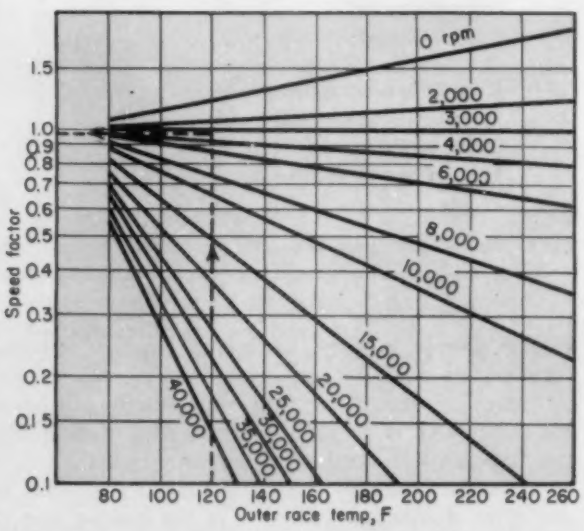


Fig. 8—Speed correction factor which must be applied to the life value obtained from data such as that in Fig. 7. Additional corrections must be applied for load, bearing size and seal efficiency.

required by the specification but a precision grade is not otherwise necessary.

In recent years, wide single-row sealed bearings have been developed having a larger grease capacity than conventional designs. These bearings, known as the cartridge type, have found widespread use in certain electric motor applications. In general, this extra quantity of grease will increase life at temperatures above 175 F.

Equipment Design

Whether or not a sealed ball bearing can be successfully incorporated into a machine or device can be determined only by the objectives of the design. If simplicity is required even at the cost of appearance, sealed bearings should be considered. For example, open bearings mounted in cast iron equipment, with smoothly formed contours and neatly arranged cover plates, may be more pleasing to the eye than steel plate construction with its bold design lines. The latter, however, housing a bearing incorporating integral seals, often represents a simpler and more economical arrangement.

Another deciding factor might be the ultimate life of the device or machine. For example, at elevated temperatures only a few thousand, or even a few hundred hours can be expected from grease-lubricated sealed bearings. If longer life is required, a sealed unit may not be practical. In still other designs, the availability of splash oil from gearing or crankshafts makes is expedient to use oil-lubricated open bearings. Conversely, if several bearings are involved and they are scattered throughout a machine it would be difficult and costly to consider any arrangement other than sealed types. Still other machinery, such as food and textile equipment, is heavily dependent upon the use of sealed ball bearings since even small quantities of oil leakage could result in product spoilage.

In hermetically sealed installations or where it is otherwise difficult or even impossible to supply lubricant to a bearing, the choice is an easy one. The problem is to determine the combination of bearing, seal and lubricant for satisfactory life and performance.

Although there are many exceptions, it appears that heavy, expensive machinery representing capital equipment generally makes use of either oil-lubricated open bearings or single seal bearings which can be relubricated, while consumer products, especially of the expendable type, show a strong tendency to be equipped with lubricated-for-life sealed bearings.

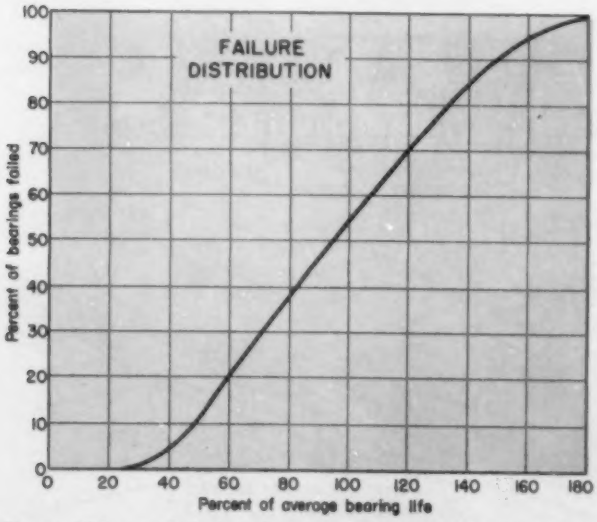


Fig. 9—Using statistical analysis techniques, the failure distribution chart for a typical group of sealed ball bearings is plotted above. Data of this type can often be used to justify or rule out a given application.

Future Trends

Integral seal designs which can be easily assembled and removed are becoming increasingly popular. They not only facilitate relubrication, but also can be applied to more diversified applications. For instance, because of their flexibility, many types can be used where vibration is moderate to severe. A seal that is rigidly fixed in the bearing ring would tend to become loose and inefficient. Another important feature is that most removable seals reduce bearing OD out-of-roundness resulting from seal assembly. This makes it possible to use them in bearings requiring high precision tolerances.

As mentioned earlier, Buna-A and polyacrylic synthetic rubbers cannot be exposed to temperatures above 225 and 350 F, respectively, for long periods of time. Aside from being expensive, the polyacrylic material is drastically affected by diester lubricants, especially at its high temperature limit.

Since current trends are directed towards higher speeds and elevated temperatures, there is a need for flexible synthetic sealing materials with low friction characteristics that will operate at 500 F and above. In addition, they should be resistant to all ball bearing lubricants.

Teflon and silicones are two relatively new synthetics which will withstand 500 F. The former is a thermoplastic resin with a very low coefficient of friction. The main drawbacks are its high cost and rigidity. Except for a few limited applications, Teflon alone is too stiff to be an effective sealing element.

Silicone rubber, on the other hand, is a resilient flexible material and has been used successfully in many applications. Great advancements have been made over the past few years in improving its temperature resistance and durability. The most serious objections to silicone rubber are high cost and inability to resist silicone lubricants.

Research on greases will also play an important part in the progress of integral-seal bearings. Currently available lubricants are not entirely satisfactory, particularly at high and low temperatures.

EDITOR'S NOTE—Data on several of the developments and materials discussed by the author in his section "Future Trends" have been presented in recent issues of *Product Engineering*. For example, with respect to seal materials there were the following:

"Producing Teflon Parts," by R. R. Miller, June 1954, page 183.

"Fluorocarbon Plastics Today," by Henry Lee, October 1954, page 168.

"Fluoroacrylitic Elastomers," by H. C. Hamlin, November 1954, page 161.

In the field of lubricants, a comprehensive evaluation of the silicone types for extreme temperature applications was presented in "Silicone Oils and Greases," November 1954, page 154. See also "High Viscosity Silicone Fluids for Mechanical Applications," by W. J. Dugan, July 1954, page 137.

Photoelectric Controls

PHOTOSWITCH DIVISION, ELECTRONICS CORPORATION OF AMERICA

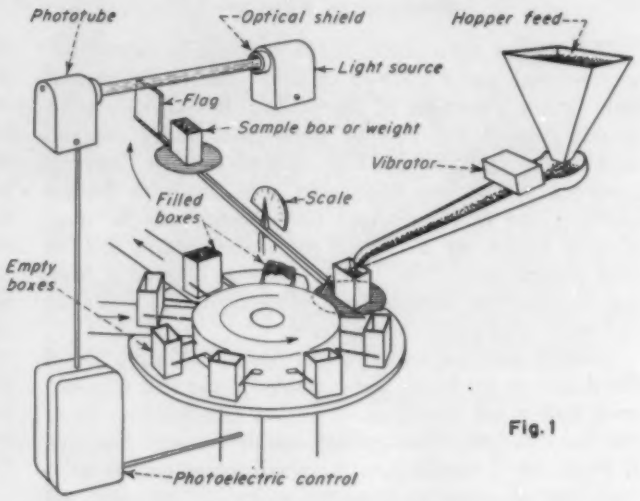


Fig. 1

FIG. 1—Automatic weighing and filling. Problem is to fill each box with exact quantity of products such as screws. Electric feeder vibrates parts through chute and into box on small balance. Photoelectric control is mounted at rear of scale. Light beam is restricted to very small dimensions by optical slit. Control is positioned so that light is interrupted by balanced cantilever arm attached to scale when proper box weight is reached. Photoelectric control then stops flow of parts by de-energizing feeder. Simultaneously, indexing mechanism is activated to remove filled box and replace with empty one. Completion of indexing motion re-energizes feeder which starts flow of screws.

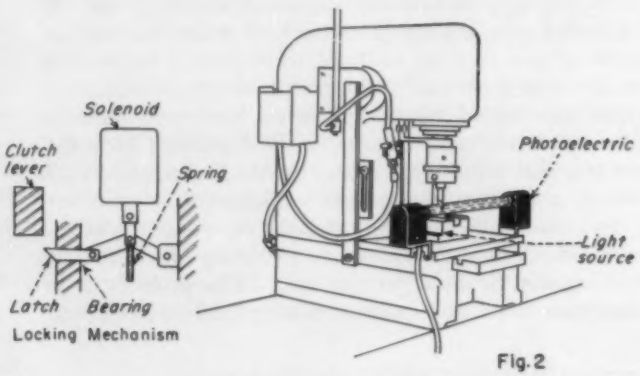


Fig. 2

FIG. 2—Operator safeguard. Most presses operate by foot pedal leaving hands free for loading and unloading operations. This creates a safety hazard. Use of mechanical gate systems reduce production speeds. With photoelectric controls, curtain of light is set up with multiple series of photoelectric scanners and light sources. When light is broken at any point by operator's hand, control energizes a locking mechanism which prevents punch press drive from being energized. Wiring is such that power or tube failure causes control to function as though light beam was broken. In addition, the light is frequently used as the actuating control since clutch is thrown as soon as operator removes his hand from the die.

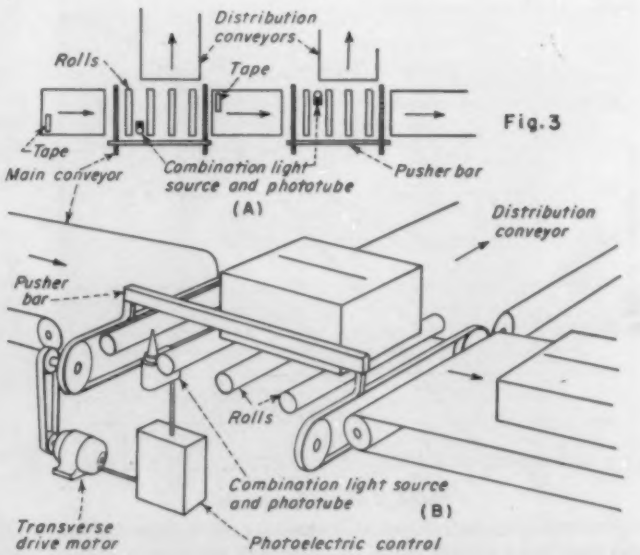


Fig. 3

FIG. 3—Sorting cartons of three types of electronic tubes. Since cartons containing one type differ widely as to size, it is not feasible to sort by carton size and shape. Solution: small strip of reflecting tape is placed on cartons by a packer during assembly. For one type of tube, strip is placed along one edge of bottom and extends almost to the middle. For second type, strip is located along same edge but from middle to opposite side. No tape is used for third type. Cartons are placed on conveyor so that tape is at right angle to direction of travel. Photoelectric controls, shown in *A*, "see" the reflecting tape pass and operate pusher bar mechanism, shown in *B*, which pushes carton on to proper distribution conveyor. Cartons without tape pass through.

FIG. 4—Cut-off machine uses photoelectric control for strip material which does not have sufficient mass to operate a mechanical limit switch satisfac-

Some typical applications for reducing production costs and increasing operator safeguards by precisely and automatically controlling the feed, transfer or inspection of products from one process stage to another.

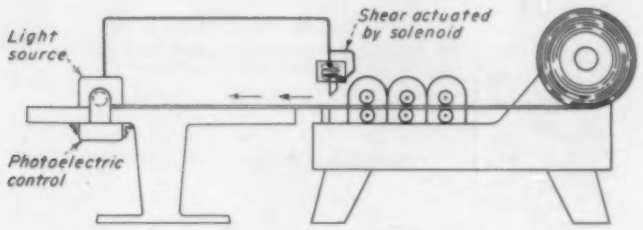


Fig. 4

torily. Forward end of strip breaks light beam thus actuating the cut-off operation. Light source and control is mounted on adjustable stand at end of machine so that length of finished stock can be varied.

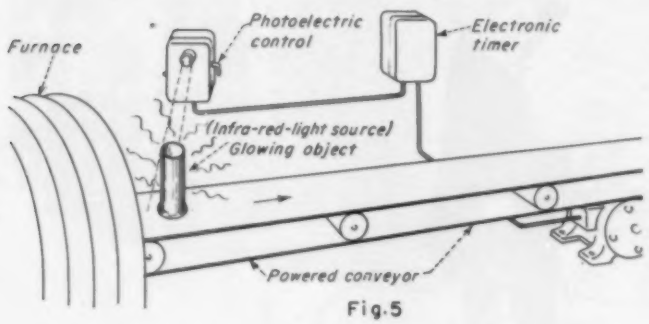


Fig. 5

FIG. 5—Heat treating conveyor uses electronic timer in conjunction with photoelectric control to carry parts emerging from furnace at 2300 F. Problem is to operate conveyor only when a part is placed on it and only for distance required to reach next process stage. Parts are ejected on to conveyor at varying rates. High temperatures caused failures when mechanical switches were used. Glowing white-hot part radiates infra-red rays which actuates photoelectric control as soon as part comes in view. Control operates conveyor which carries part away from furnace and simultaneouslyy starts timer. Conveyor is kept running by timer for predetermined length of time required to positon part for next operation.

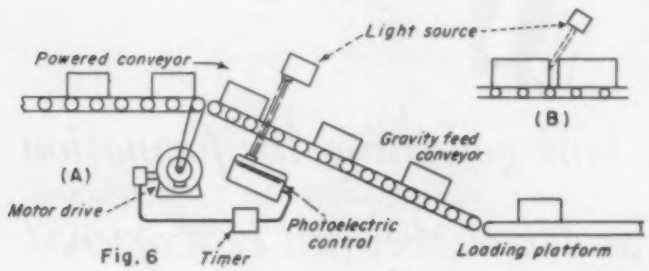


Fig. 6

FIG. 6—Jam detector. Cartons jamming on conveyor cause loss of production time and damage to cartons, products and conveyors. Detection is accomplished with a photoelectric control using a timer as shown in (A). Each time a carton passes light source, control beam is broken which starts timing interval in the timer. Timing circuit is reset without relay action each time beam is restored before preset timing interval has elapsed. If jam occurs causing cartons to butt one against the other, light beam cannot reach control. Timing circuit will then time out, opening load circuit which stops conveyor motor. By locating light source at an angle to conveyor, as shown in (B), power conveyor can be delayed if cartons are not butting but are too close to each other.

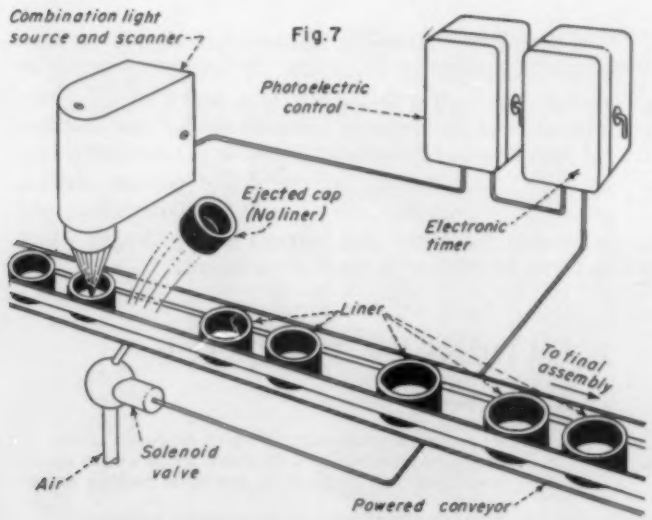
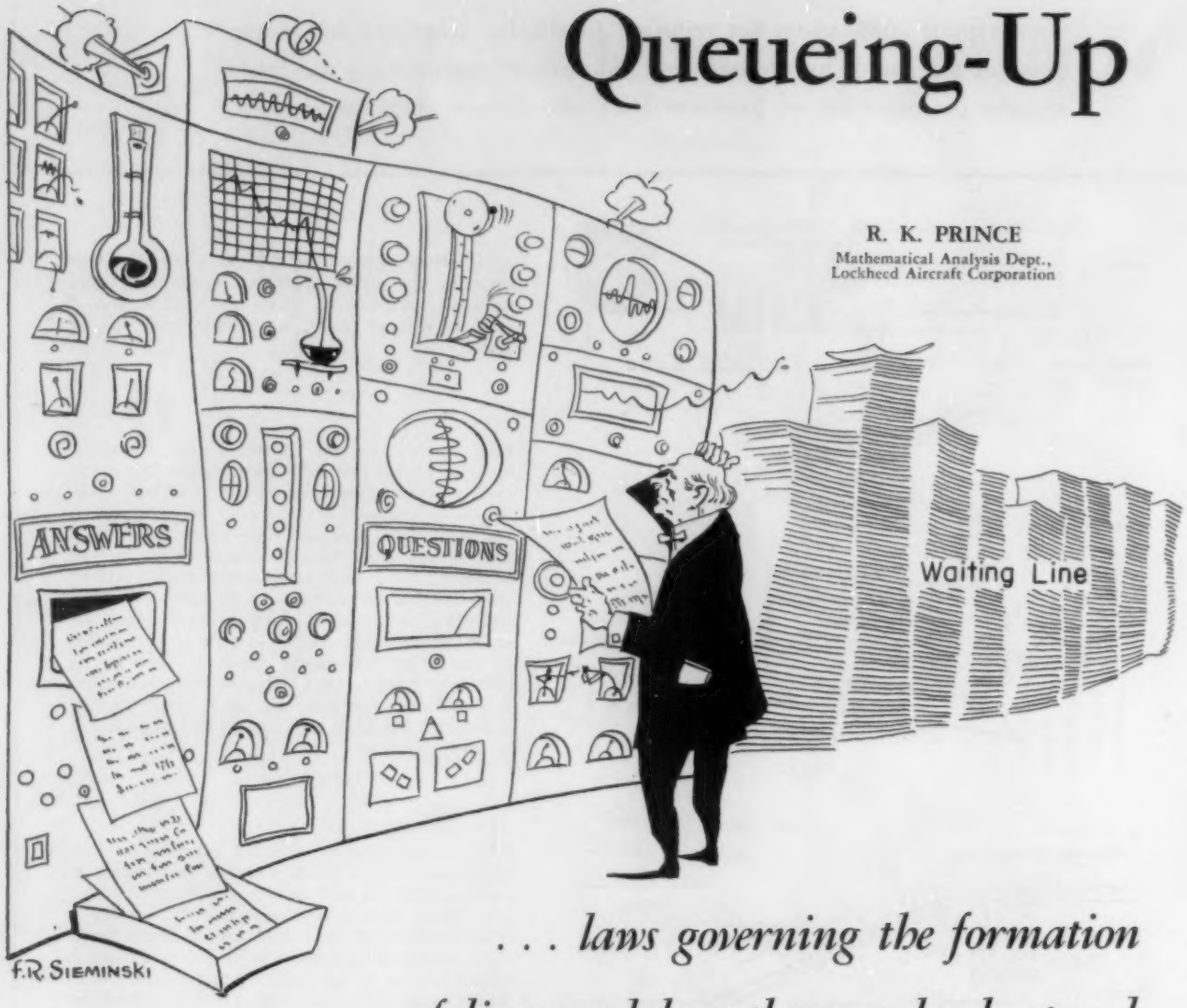


Fig. 7

FIG. 7—Automatic inspection. As steel caps are conveyed to final assembly, they pass intermediate stage where an assembler inserts insulation liner into cap. Inspection point for missing liners has reflection-type photoelectric scanner which incorporates both light source and phototube with common lens system to instantly recognize difference in reflection between dark liner and light steel cap. When it detects a cap without a liner, a relay operates ejector device composed of air blast controlled by solenoid valve. Start and duration of air blast is accurately controlled by timer so that no other caps are displaced.

Queueing-Up

R. K. PRINCE
Mathematical Analysis Dept.,
Lockheed Aircraft Corporation



. . . laws governing the formation of lines and how they can be shortened

A PHENOMENON peculiar to a civilized society is that of "queueing-up," or standing in line and waiting. Lines form at ticket windows, bus stops, and bank tellers' cages. The scheduling of development projects in an engineering office or drafting room, the flow of fabricated parts through inspection rooms, or the delay when a problem is submitted for solution in a computing installation are all situations to which the following analysis is applicable.

MATHEMATICAL MODEL OF QUEUEING

Experience teaches us that queueing-up is based on elements having random variations. New members join the tail of the queue at irregular intervals, and members at the head of the queue are served and depart at irregular intervals. Even the length of the queue has no particular fixed value.

If we are to construct a mathematical model, we must assume regularity of some sort. It seems reasonable to assume that, over a sufficiently long period of time, new members join the queue at a definite average rate and that old members are served and depart at a (different) average rate. This assumption specifically permits random variations in both the rate of arrival and departure; and infers that the queue will have an average length which also will be subject to random variations.

EQUATIONS OF THE QUEUE

Let us define:

A = (long-time) average rate at which problems arrive
S = (long-time) average rate at which problems are solved
n = (instantaneous) number of problems waiting in the queue
P_n = probability of the queue containing n problems

P_n is simply the fraction of the total time that the queue

is n problems long. n may be any positive integer, including zero (no queue).

For convenience, we assume that the queueing-up has been under way long enough so that, on the average, equilibrium has been obtained. The problems are, on the average, arriving as fast as they are leaving. For instance, a queue of length $n = 1$ is created from a queue of length $n = 0$ at an average rate of P_0A, while it is served and leaves at an average rate of P_1S. Hence,

$$P_1S = P_0A \tag{1}$$

Similar reasoning for queues of length $n = 2$ and $n = 3$ leads to

$$P_2S = P_1A$$
$$P_3S = P_2A \tag{2}$$

And we deduce the recurrence equation

$$P_nS = P_{n-1}A \tag{3}$$

or

$$P_n = P_{n-1}\frac{A}{S} \tag{3a}$$

which is the same as the geometric progression

$$P_n = P_0\left(\frac{A}{S}\right)^n \tag{4}$$

To evaluate P_0, we notice that (including queues of length zero) there will always be a queue of some length, and so

$$1 = \sum_{n=0}^{\infty} P_n$$

$$1 = \sum_{n=0}^{\infty} P_0\left(\frac{A}{S}\right)^n \tag{5}$$

If $0 \geq A/S < 1$, the sum of the infinite series is

$$1 = P_0\left(\frac{1}{1-\frac{A}{S}}\right)$$

Note that if $A > S$, the queue would grow indefinitely and no equilibrium could be reached.

Solving for P_0

$$P_0 = 1 - \frac{A}{S} \tag{6}$$

which, substituted in Eq (4) gives

$$P_n = \left(1 - \frac{A}{S}\right)\left(\frac{A}{S}\right)^n \tag{7}$$

The (long-time) average length m of the quene is

$$m = \frac{\sum_{n=0}^{\infty} nP_n}{\sum_{n=0}^{\infty} P_n} = \frac{\sum_{n=0}^{\infty} n\left(1 - \frac{A}{S}\right)\left(\frac{A}{S}\right)^n}{1} \tag{8}$$

The sum may be evaluated, giving

$$m = \frac{\frac{A}{S}}{1 - \frac{A}{S}} \tag{9}$$

Table I gives values of P_n and m for typical values of n and A/S.

EQUATIONS OF WAITING

When a problem arrives, it will find a queue of length n ahead of it. The delay D before the new problem will be considered (in units of the average time of solution $T = 1/S$) is thus

$$D = n \tag{10}$$

Table I—Probability of Occurrence of Queues of Length n

Length of Queue, n	A/S 0.3	0.4	0.5	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
0	0.7000	0.6000	0.5000	0.4000	0.3500	0.3000	0.2500	0.2000	0.1500	0.1000	0.0500
1	0.2100	0.2400	0.2500	0.2400	0.2275	0.2100	0.1875	0.1600	0.1275	0.0900	0.0475
2	0.0630	0.0960	0.1250	0.1440	0.1479	0.1470	0.1406	0.1280	0.1084	0.0810	0.0451
3	0.0189	0.0384	0.0625	0.0864	0.0961	0.1029	0.1055	0.1024	0.0921	0.0729	0.0429
4	0.0057	0.0154	0.0312	0.0518	0.0625	0.0720	0.0791	0.0819	0.0783	0.0656	0.0407
5	0.0017	0.0061	0.0156	0.0311	0.0406	0.0504	0.0593	0.0655	0.0666	0.0590	0.0387
6	0.0005	0.0025	0.0078	0.0187	0.0264	0.0353	0.0445	0.0524	0.0566	0.0531	0.0368
7	0.0002	0.0010	0.0039	0.0112	0.0172	0.0247	0.0334	0.0419	0.0480	0.0478	0.0349
8	0.0000	0.0004	0.0020	0.0067	0.0112	0.0173	0.0250	0.0336	0.0409	0.0430	0.0332
9		0.0002	0.0010	0.0040	0.0072	0.0121	0.0188	0.0268	0.0347	0.0387	0.0315
10		0.0001	0.0005	0.0024	0.0047	0.0085	0.0141	0.0215	0.0295	0.0349	0.0299
11		0.0000	0.0002	0.0015	0.0031	0.0059	0.0106	0.0172	0.0251	0.0314	0.0284
12			0.0001	0.0009	0.0020	0.0042	0.0079	0.0137	0.0213	0.0282	0.0270
13			0.0001	0.0005	0.0013	0.0029	0.0059	0.0110	0.0181	0.0254	0.0257
14			0.0000	0.0003	0.0008	0.0020	0.0045	0.0088	0.0154	0.0229	0.0244
15	0.0000	0.0000	0.0000	0.0002	0.0005	0.0014	0.0033	0.0070	0.0131	0.0206	0.0232
Avg. Length of Queue m	0.43	0.67	1.00	1.50	1.86	2.33	3.00	4.00	5.67	9.00	19.00

Now, the probability P_D of a delay D is simply the probability P_n of a queue of length n; and so, from Eq (7)

$$P_D = \left(1 - \frac{A}{S}\right)\left(\frac{A}{S}\right)^D \tag{11}$$

The probability P_k of a problem being delayed by at least an interval $K = D$ is

$$P_k = \sum_{D=k}^{\infty} P_D$$

$$= \left(\frac{A}{S}\right)^k \tag{12}$$

by summation of the series. K is in units of the average time of solution, $T = 1/S$. The corresponding actual time T_k is

$$T_k = \frac{K}{S} \tag{13}$$

And Eq (12) may also be written

$$P_k = \left(\frac{A}{S}\right)^{T_k S} \tag{14}$$

Finally, the average length of the queue is m (Eq (9). At the average rate of solution S, the time T_m of the average delay is

$$T_m = \frac{m}{S}$$

$$= \frac{K_m}{S} \tag{15}$$

Table II gives values of P_k and K_m for typical values of D and A/S.

COMPARISON WITH EXPERIENCE

During the period from January 1952 through June 1953, a total of 98 separate problems in a particular repetitive problem were submitted and solved. These problems spent a total of 420 problem-days waiting (before being worked on) and a total of 385 problem-days in solution (being worked on). The average number of problems m in the queue is thus

$$m = \frac{420}{385}$$

$$= 1.091$$

From Eq (9), the corresponding value of A/S is

$$1.091 = \frac{\frac{A}{S}}{1 - \frac{A}{S}}$$

$$\frac{A}{S} = 0.522$$

Using this value in Eq (7), the theoretical numbers of times a queue of given length should have occurred may be compared with experience. They are listed side by side in Table III.

Similarly, the corresponding occurrences of problems which are delayed by at least n may be computed from Eq (12) and compared with experience. They are listed side by side in Table IV.

The elapsed time experienced with the 98 problems may be plotted as a function of problem size. The fastest practicable time of solution for the methods used, as determined by machine capabilities, would be plotted as the line $(1 - P_k) = 0$. The increments in elapsed time for the remaining values of $(1 - P_k)$ are computed from Eq (14). The theoretical and observed occurrences of problems lying below a given $(1 - P_k)$ line are listed in Table V. Considering the size of the experiment, these indicate a remarkable correspondence between theory and practical experience.

THE PARADOX OF THE QUEUE

Eq (12) is the mathematical formulation of the Paradox of the Queue, which is: no matter how great the rate at which problems are solved, still some of the problems will be delayed by standing in a queue.

Table II—Probability of a Delay at Least K Long

Delay K (Fraction of Basic Solution Time, $1/S$)	A/S										
	0.3	0.4	0.5	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
0.2	0.776	0.832	0.871	0.903	0.917	0.931	0.944	0.957	0.968	0.979	0.990
0.5	0.548	0.633	0.707	0.775	0.806	0.837	0.866	0.895	0.922	0.949	0.975
1.0	0.300	0.400	0.500	0.600	0.650	0.700	0.750	0.800	0.850	0.900	0.950
2.0	0.090	0.160	0.250	0.360	0.422	0.490	0.562	0.164	0.722	0.810	0.903
5.0	0.002	0.012	0.031	0.078	0.116	0.168	0.237	0.328	0.442	0.591	0.774
10.0	0.000	0.000	0.001	0.006	0.014	0.028	0.057	0.107	0.196	0.350	0.599
20.0			0.000	0.000	0.000	0.001	0.003	0.014	0.038	0.122	0.358
50.0						0.000	0.000	0.000	0.000	0.005	0.076
100.0										0.000	0.006
Avg. Delay K_m	0.43	0.67	1.00	1.50	1.86	2.33	3.00	4.00	5.67	9.00	19.00

Table III—Theoretical and Actual Occurrences of a Queue of Length *n*

Length of Queue, *n*	Actual Occurrences	Theoretical Occurrences
0	44	47
1	20	24
2	18	13
3	6	7
4	8	4
5	2	2
6	0	1
7	0	0

Table IV—Theoretical and Actual Occurrences of Problems Delayed by at Least *n*

Length of Queue, *n*	Actual Occurrence	Theoretical Occurrence
0	98	98
1	54	51
2	34	27
3	16	14
4	10	7
5	2	4
6	0	2
7	0	1

Table V—Theoretical and Actual Occurrences of Problems Lying Below a Given $(1—P_k)$ line are

$1\ m\ P_k$	Actual Occurrence	Theoretical Occurrence
0	1	0
0.25	22	24
0.50	49	49
0.75	66	73
0.85	77	83
0.90	83	88
0.95	93	93

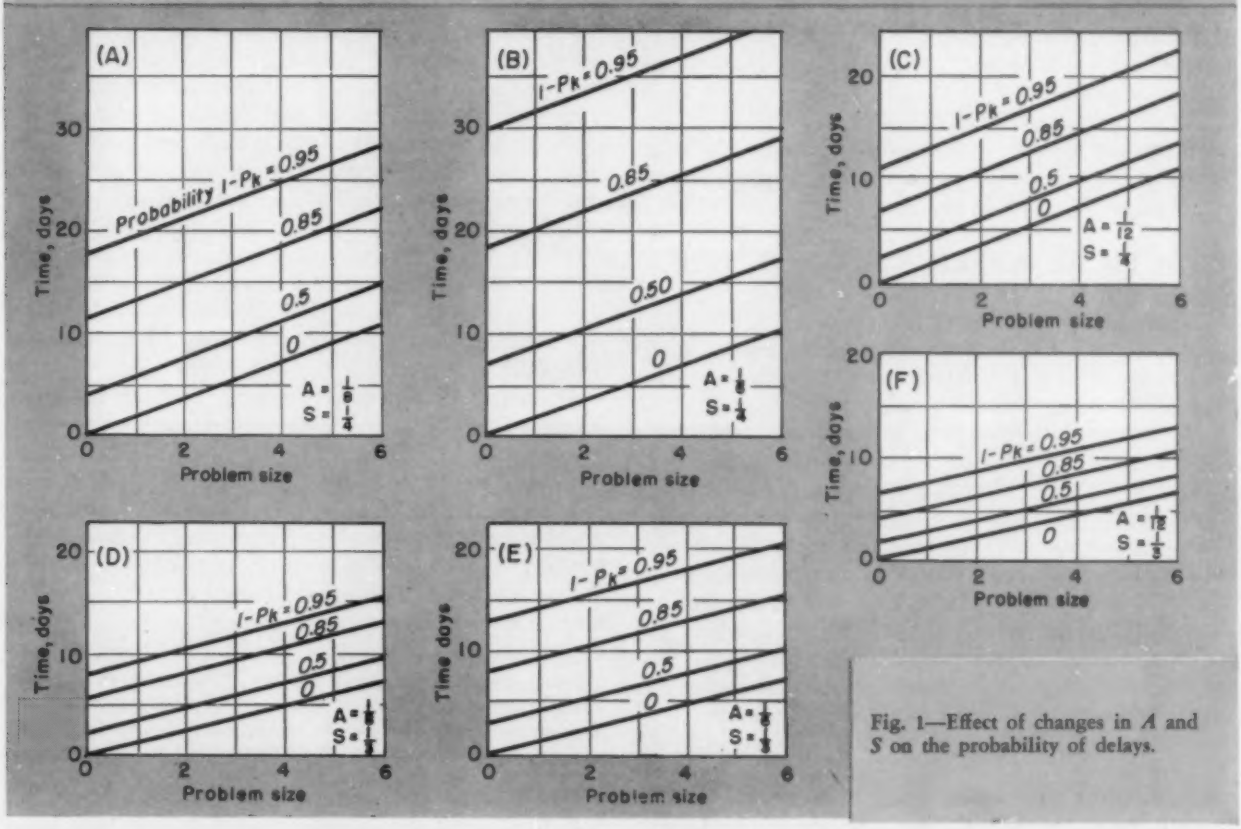


Fig. 1—Effect of changes in *A* and *S* on the probability of delays.

The explanation of the paradox is deceptively simple. Obviously, if the problems are submitted at a regular rate which is less than the rate at which the problems are solved, then every problem is solved before the next arrives; there is never a queue or a delay. But the problems actually arrive at random intervals (because they arise at random intervals). Sooner or later, then, a group of problems arrives which is so closely spaced that the last problem arrives while the others are still being solved; there is now a queue and a resultant delay.

The practical experience cited in the preceding section is typical of the paradox. Here, even though twice as many problems could have been solved as were submitted, yet half of the problems submitted were therefore delayed.

EFFECTS OF PARAMETER CHANGES

To give some indication of the effects of varying the rates of arrival and of solution, we pick values of $A = \frac{1}{8}$ and $S = \frac{1}{4}$ (A, Fig. 1) which are practically those found in current experience; the other graphs of Fig. 1 represent an increase or decrease by one-third in these values.

An increase of one-third in the volume of problems

(with constant computing capacity) produces the increased probability of long delays shown in *B* of Fig. 1. The increased probability of long delays would probably be found intolerable (the condition at *A* is presumably marginal). A corresponding decrease in the volume of problems produces the improvement shown at *C* in Fig. 1. The improvement at *C* is not as large as the degradation at *B*.

An increase of one-third in the computing capacity (with constant volume of problems) produces the decreased probability of long delays shown at *D* in Fig. 1. Comparison of *C* and *D* indicate that, for the same relative change, changing the computing capacity has greater effect than decreasing the volume of problems.

Increasing both the computing capacity and the volume of problems produces *E* in Fig. 1. *E* shows a distinctly smaller probability of long delays than *A*, in spite of the fact that the relative loading *A/S* of the computing installation is the same. In consequence, if the computing capacity is able to keep pace with a growth in the volume of problems, there will be an automatic decrease in the average waiting time. Again, and possibly more important, if a fixed delay is permissible, the growth of computing capacity need not be quite so fast as the growth in the volume of problems.

For completeness, *F* in Fig. 1 shows the effect of a simultaneous increase in computing capacity and a decrease in the volume of problems. This happy combination has yet to occur in practice.

PRACTICAL APPLICATION OF THE QUEUEING-UP THEORY

Just as much a part of the queueing-up process as the waiting is the disgust at being forced to wait. When the disgust becomes sufficiently strong and widespread, action must be taken to reduce it to tolerable levels. It is here that the theory of the queueing-up process can find practical application. By predicting the result of any particular proposed remedy, it will permit picking an optimum action for a given situation. (Such an action is usually intended to give an economic optimum. The mathematics of an economic optimum are deferred to a subsequent study).

Several possible actions are immediately evident. All of the following actions have been taken at various computing installations, and (by verbal evidence) the predicted results were obtained identically. These are:

1. *Rationing.* The fundamental reason for the existence of the queue is the randomness with which the problems are submitted. If the arrival of the problems is scheduled properly, each problem will arrive as its predecessor departs, and there need be no queue in the computing installation. Of course, the problems still arise at random intervals, and some must wait their turn to be submitted for solution. The problems are still waiting in a queue as before, but the queue is now hidden "around the corner." The difficulty is that the queue is a symptom and not the disease. In hiding the symptom, the actual disease (relative shortage of computing capacity) may go unnoticed too long. Rationing is, however, of definite benefit to the computing installation. The disgust at being forced to wait is transferred from the computing installation to "the system."

2. *Priorities.* Usually it is possible to assign relative importance to members of a given group of problems, and to form a queue on this basis. There is still just as much waiting to be done, but it will be done by the problems of lesser importance. Unfortunately, problems which merit priority at all usually are associated with scheduled work, and delay in solving the problem automatically raises the priority of the problem. In the long run, each problem will tend to wait until its priority is as high as the highest. At this point, all problems have equal priority, which leads to questions of why a top-priority problem goes to the end of a queue (of top priority problems). The priority system has the dubious distinction of creating disgust both at the computing installation and at "the system."

3. *Deferment.* The average length of a queue may be markedly reduced by reducing the influx of problems and, in consequence, the relative loading *A/S* of the computing installation, Table I. On occasion such reduction is made by executive decree. Experience shows that most of the problems eliminated by such action are not actually eliminated, but simply deferred to such a time that further postponement is impractical. (That is, the solutions were necessary to begin with.) If all deferred problems may be deferred equally, deferment postpones the time an actual improvement must be found. In practice, problems so deferred have tended to add to a subsequent nondeferable work load. Because the average length of queue is not proportional to the relative loading of the computing installation, this is more serious than it sounds. A value of $A/S = 0.6$ gives an average queue of 1.50; deferring half of the problems ($A/S = 0.3$) gives an average of 0.43, Table I. When these can no longer be deferred, then $A/S = 0.9$ and the average queue is 9.00. Thus an improvement by a factor of $1.50/0.43 \approx 3.5$ has been purchased by a subsequent worsening by a factor of $9.00/1.50 \approx 6.0$.

4. *Increased Capacity.* Increasing the rate at which problems can be solved gives a two-fold improvement. The decrease in the loading of the computing installation *A/S* leads to much shorter average queues, Table I, and the increased rate of solution increases the speed with which a problem passes through the already shorter queue. Further, the probability of relatively long queues is spectacularly reduced as *A/S* decreases (Table I, $n \approx 3$). The difficulty encountered in increasing capacity is that it usually implies adding to equipment which is not being used to capacity even before the addition. To people not familiar with the paradox of the queue, this seems a needless expense.

CONCLUSIONS

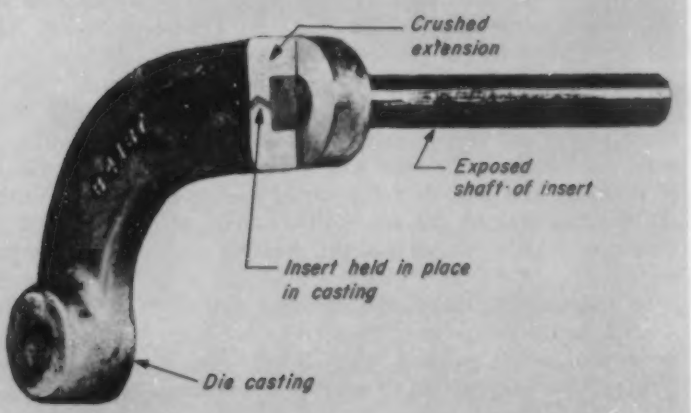
1. In a practical computing installation, at least some of the problems will be delayed by waiting in a queue.

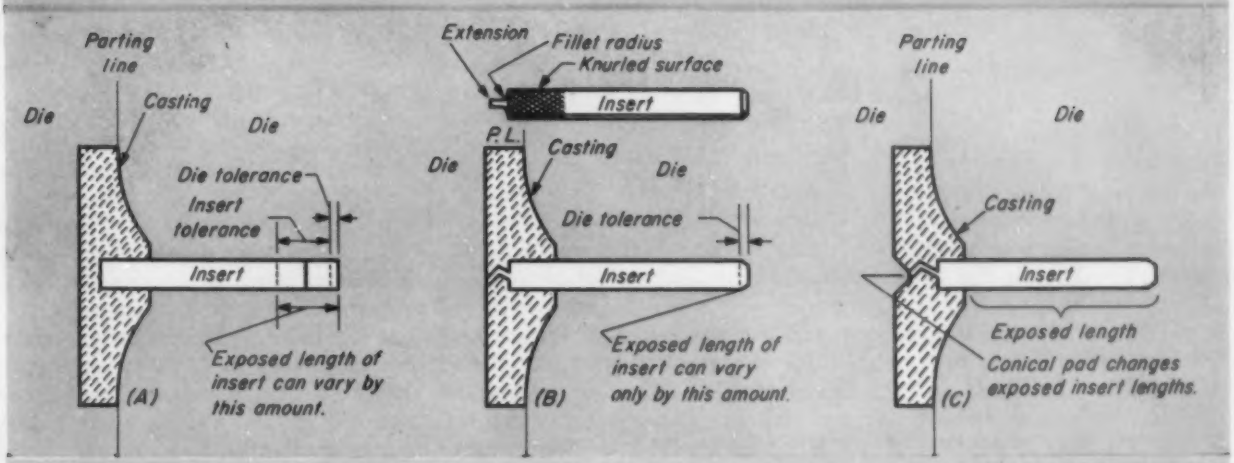
2. In the long run, the only way in which the period of delay can be modified is by changing the capacity of the computing installation.

3. If problems associated with scheduled work are not to suffer (more or less frequent) intolerable delays, the computing installation must not be heavily loaded with such work.

4. If the capacity of the computing installation is large enough to avoid intolerable delays on scheduled work, there will be an appreciable fraction of the capacity available (at random intervals) for solving problems not associated with scheduled work.

Die Cast Insert Redesign Cuts Production Costs





IN THE ORIGINAL METHOD of casting-in rod and shaft inserts (left) wide tolerances on exposed shaft lengths are hard to avoid because of insert-length and die tolerances and the wide latitude on positioning of the insert when the die is closed. By making the overall insert length, including the small diameter extension, longer than the closed die cavity (center) the "exposed" end will always be positioned at the base of the die cavity, thus assuring uniformity for all castings. Where longer exposed lengths of a given insert shaft are required, a conical pad applied to the die (right) will allow "standard" inserts to serve different designs.

EDWARD L. KELLY
Ampex Corporation

USUAL PROCEDURE for assembly of a rod or shaft into a die casting is to place the insert into one half of the die, then close the die and feed molten metal into the cavity. This was the method employed for inserts in Ampex magnetic tape recorders. The resulting overall dimensional tolerance depends on tolerance on insert length, and the die tolerance, as shown at A. A "tight" fit is accomplished by knurling the end of the shaft for the length of insertion. In practice, tight tolerances are difficult to hold without high cost for special jigs, closer control of individual tolerances, sorting of shafts by length, and use of shims; thus, a high percentage of rejects result.

Usual methods considered for achieving closer tolerances included (1) shimming during assembly in the equipment; (2) boring accurate holes in the die castings and pressing in the shafts; (3) holding extremely tight tolerance on insert length; and (4) use of adjustable collars over the shaft. All these methods were eventually discarded because of excessive cost. Shimming took too much time; boring accurate holes for pressed insert assembly resulted in a high order of rejects; holding tight tolerances on

insert length increased machining cost; and adjusting collars proved complicated and time consuming in adjustment.

The "Crushed Insert" Method

The idea that finally solved the problem was the "crushed insert" method which made it possible to fabricate the inserts in automatic screw machines without concern for the resulting wide tolerances. As shown at (B), the insert is modified by machining a reduced diameter extension on the knurled end which is subsequently crushed during closing of the die-casting die as shown. Resistance to crushing on closure of the die forces the insert to the end of the cavity in all cases. All finished parts will then have the same length except for the effects of shrinkage and possible collection of foreign matter in the locating end of the die cavity, minimized by the clearance chamfer shown on the locating end of the insert.

In designing the inserts, the diameter of the extension must be small enough to collapse easily, yet large enough to be easily machined and relatively safe from handling damage. For example; on an insert ¼ in. in dia, an extension ⅛ to ¼ in. long with a diameter of 3/32 to 5/32 in. has proven practical. A small fillet radius makes machining easier and reduces stress concentration during crushing.

One precaution should be observed: The insert length exclusive of the extension (from locating end to shoulder of the extension) should be shorter than the die cavity by at least twice the extension diameter, to insure ample space in case the extension is completely doubled over during crushing.

The crushed extension tends to anchor the insert in the casting; yet, it is still good practice to retain the knurling to assure tight anchorage.

Further savings are obtained on parts having inserts of the same diameter but of different exposed lengths. Originally a different insert was required for each length. With the "crushed insert" method, one standard insert can be used where various exposed lengths are needed by providing an appropriate conical protrusion in the casting die as shown at (C).

The "crushed insert" technique has been successfully employed with zinc and aluminum die castings with many types of steel inserts, including case-hardened stainless.

Army Gets Its First Reactor

LIKE MANY REACTORS developed in the rapidly expanding atomic energy program, there are a number of "firsts" connected with Alco Products, Inc.'s nuclear power plant. It is the *first* nuclear power plant to be installed in the Washington, D. C. area; the Army Package Power Reactor (APPR) will be the Army's *first* nuclear power plant; and it will be one of the *first* atomic powered generating stations to be built close to a large center of population. Announced at the first U. S. Trade Fair of Atomic Energy held in Washington recently, the unit will be built at Fort Belvoir overlooking the Potomac River during 1956, and is scheduled for operation early in 1957.

Maximum accident precautions were taken in the power plant's design, and the major design consideration was to provide for the containment of any accident which could be predicted, and which might release radioactive materials into the area in great amounts. This was accomplished by enclosing the nuclear reactor in a steel vapor container 32 ft. in diameter and 60 ft. high. This container is designed to withstand the maximum pressure which would result from any accident. As a precaution against any high velocity reactor parts, a two foot concrete interior lining will be added to the container. However, since all parts of the Package Reactor have been designed to permit air transport to remote locations, an iron-water shield around the reactor will be provided to save weight if the concrete normally used is not available at the location.

The APPR will be an 1825 KW plant. The reactor will be operated at a 10 megawatt power level, but it is expected that this level can be increased by at least 20 per cent without overload once the plant is in operation.

The reactor will be 20 in. square, but with the corners omitted to almost make it in the shape of a cylinder. The fuel elements are 2¾ in. square, with allowable space for 45 elements. Forty of these are actual fuel elements, while five are control rods. The primary shielding will consist of an iron and water-layered shield 47 in. in radial thickness which will surround the reactor completely.

Primary cooling is accomplished by circulating pressurized water through a closed loop made up of the reactor, steam generator, and two circulating pumps. The primary circuit will be maintained at 1200 psi to prevent boiling (saturation temperature 568 F). Water leaves the reactor at 450 F, and enters the steam generator, which is made up of U-tubes which are surrounded by water in the secondary circuit. The primary water is cooled at 431 F at full load, and when it leaves the steam generator it is returned to the reactor by a "canned-rotor" type pump.

Steam is generated at 200 psi (382 F saturation temperature) at full load, and superheated 25 deg. to reduce condensation in the last turbine stages. At decreasing loads, because of a nearly constant primary coolant inlet temperature to the steam generator, the saturation temperature on the secondary side will approach 450 F, so that at no load, steam will be generated at nearly 425 psi. Turbine inlet pressure will be about 190 psi, but the turbine will be designed for 250 psi inlet pressure to allow an operating margin for increased inlet pressure at partial load. Electrical power is generated by a 2000 KW, 4160 volt, 3 phase, 60 cycle turbo-generator unit.

The stability of the reactor is such as to make it impossible for a reactor run-away to occur which would be great enough to rupture the system. Even if this did happen, the release of any radioactive material to the air would be next to impossible.

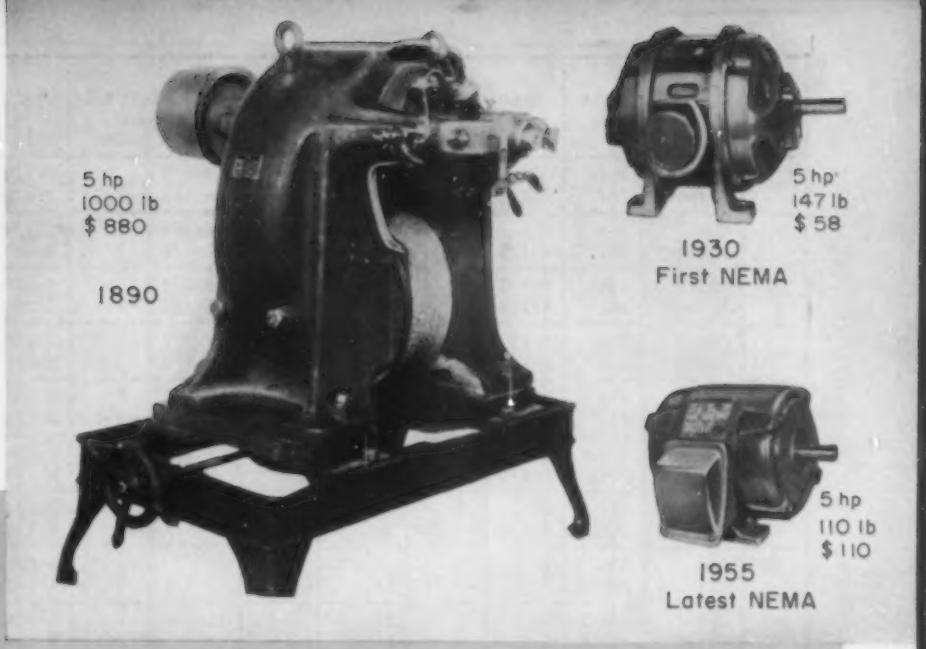


Fig. 1—Continuing program of improvement in Westinghouse polyphase induction motors from 1894 to present. Motors shown are 5 hp-ratings. Curious fact is that although size and weight have been considerably reduced, cost-per-pound is approximately the same today as it was in 1880.

NEMA Rerate Motors

Dimensional differences between old and rerated NEMA motors bring up a problem of motor interchangeability for first time in 25 years, but principal adjustments can be made by use of spacer bars. Dimensional differences are compared and bar dimensions given for foot-mounted motors.

NEMA Frame size series	180	200	210	220	250	280	320
Shaft height, in.	4½	5	5¼	5½	6¼	7	8
1930 hp ratings	None	1	None	1½-2-3	5	7½	10-15
1940 hp ratings	None	1-1½	None	2-3	5	7½	10-15
1953 hp ratings	1-1½-2	None	3-5	None	7½-10	15-20	25-30

Fig. 2—Comparison of ratings for frame sizes of old and rerated motors. Note that only five of the seven frame sizes have been included in any one series.

S. F. HENDERSON
Manager, AC Motor Development Sect., Westinghouse Electric Corp.

WHILE THE FUNDAMENTAL THEORY on which motor design is based was established early in the nineteenth century (1820-1831), it was not until the 1890's that practical industrial alternating-current motors became available. Patents were issued in 1888 to Nicola Tesla, a citizen of Austria-Hungary, covering the fundamentals of polyphase induction motors. Tesla had not actually developed commercial motors when he was brought to Pittsburgh by Westinghouse in 1888, but in the next two years a number of motors were built under his direction, Fig. 1.

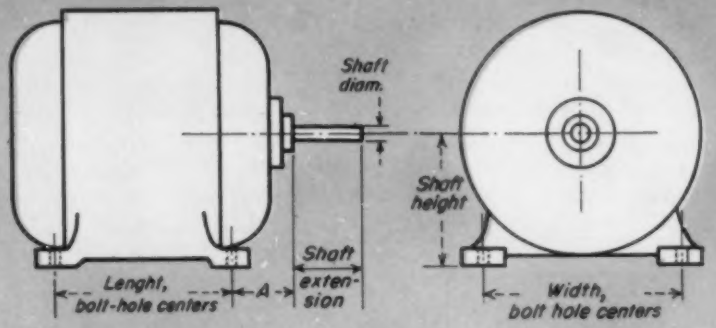
By 1894 the polyphase 60-cycle system had become accepted, and better understanding of magnetic circuits and better methods of calculation made possible a new line of induction motors. This line was superceded in 1897 by a new design which firmly established the squirrel-cage induction motor. It was in this period that machines driven by steam power from line shafting were converted to electric drives; built-in motor applications quickly followed.

Demand for a lower-cost motor with higher power factor and efficiency led to a new design introduced in 1905 which was just about one-half the weight. From this point on, changes in weight and size were more gradual.

Hp	NEMA Frame Series		Shaft Height ↓	Shaft Height Diff.	Width-bolt hole centers ↓	Width-bolt hole centers Diff.	Length-bolt hole centers ↓	Length-bolt hole centers Diff.	"A" Dimen. ↓	"A" Dimen. Diff.	Shaft Extension ↓	Shaft Extension Diff.	Shaft Dia. ↓	Shaft Dia. Diff.
1	Old	203	5		8		5-1/2		3-1/8				3/4	
	Rerated	182	4-1/2	−1/2	7-1/2	−1/2	4-1/2	−1	2-3/4	−3/8	2-1/4	0	7/8	+1/8
1.5	Old	204	5		8		6-1/2		3-1/8				3/4	
	Rerated	184	4-1/2	−1/2	7-1/2	−1/2	5-1/2	−1	2-3/4	−3/8	2-1/4	0	7/8	+1/8
2	Old	224	5-1/2		9		6-3/4		3-1/2		3		1	
	Rerated	184	4-1/2	−1	7-1/2	−1-1/2	5-1/2	−1-1/4	2-3/4	−3/4	2-1/4	−3/4	7/8	−1/8
3	Old	225	5-1/2		9		7-1/2		3-1/2				1	
	Rerated	213	5-1/4	−1/4	8-1/2	−1/2	5-1/2	−2	3-1/2	0	3	0	1-1/8	+1/8
5	Old	254	6-1/4		10		8-1/4		4-1/4		3-3/8			
	Rerated	215	5-1/4	−1	8-1/2	−1-1/2	7	−1-1/4	3-1/2	−3/4	3	−3/8	1-1/8	0
7.5	Old	284	7		11		9-1/2		4-3/4				1-1/4	
	Rerated	254U	6-1/4	−3/4	10	−1	8-1/4	−1-1/4	4-1/4	−1/2	3-3/4	0	1-3/8	+1/8
10	Old	324	8		12-1/2		10-1/2		5-1/4		4-7/8		1-5/8	
	Rerated	256U	6-1/4	−1-3/8	10	−2-1/2	10	−1/2	4-1/4	−1	3-3/4	1-1/8	1-3/8	−1/4
15	Old	326	8		12-1/2		12		5-1/4					
	Rerated	284U	7	−1	11	−1-1/2	9-1/2	−2-3/4	4-3/4	−1/2	4-7/8	0	1-5/8	0
20	Old	364	9		14		11-1/4		5-7/8		5-5/8		1-7/8	
	Rerated	286U	7	−2	11	−3	11	−1/4	4-3/4	−1-1/8	4-7/8	−3/4	1-5/8	−1/4
25†	Old	364	9		14		11-1/4		5-7/8					
	Rerated	324U	8	−1	12-1/2	−1-1/2	10-1/2	−3/4	5-1/4	−5/8	5-5/8	0	1-7/8	0
25*	Old	365	9		14		12-1/4		5-7/8					
	Rerated	324U	8	−1	12-1/2	−1-1/2	10-1/2	−3/4	5-1/4	−5/8	5-5/8	0	1-7/8	0
30†	Old	365	9		14		12-1/4		5-7/8					
	Rerated	326U	8	−1	12-1/2	−1-1/2	12	−1/4	5-1/4	−5/8	5-5/8	0	1-7/8	0
30*	Old	404	10		16		12-1/4		6-5/8		6-3/8		2-1/8	
	Rerated	326U	8	−2	12-1/2	−3-1/2	12	−1/4	5-1/4	−1-3/8	5-5/8	−3/4	1-7/8	−1/4

†Open motors. *Totally-enclosed, fan-cooled motors.

Fig. 3—Comparison of significant mounting and shaft dimensions of old and rerated 1800-rpm, foot-mounted motors. Differences in shaft height, shaft diameter, shaft extension, and mounting dimensions are included in tabulation.



Increase in manufacturing volume was responsible for development of smaller and less expensive motors in 1913, marking a basic change in motor design due to modification and improvement of details and development of economical manufacturing methods. The 1922 motor represented further development in this direction.

Work on a standardized line of motors began about 1928 to meet a demand among machine-tool and automobile manufacturers for interchangeable motors. This involved development of completely new lines of motors by all motor manufacturers. The National Electrical Manufacturers Association was formed, standards were developed, and the first line built to NEMA dimensions was introduced in 1930. Except for minor revisions about 1940, made on 2 hp and less and rerating of 30 hp and larger, standards adopted in 1930 continued until 1952 when new ratings were adopted on motors of 1-30 hp.

NEMA standards of performance covering temperature rise, pullout torque, and locked-rotor current are exactly the same for both old and rerated motors. But for a given size, rerated motors have horsepower ratings about 200 per cent that of the old equivalent; for a given rating the rerated motor has a volume only two-thirds that of the old type.

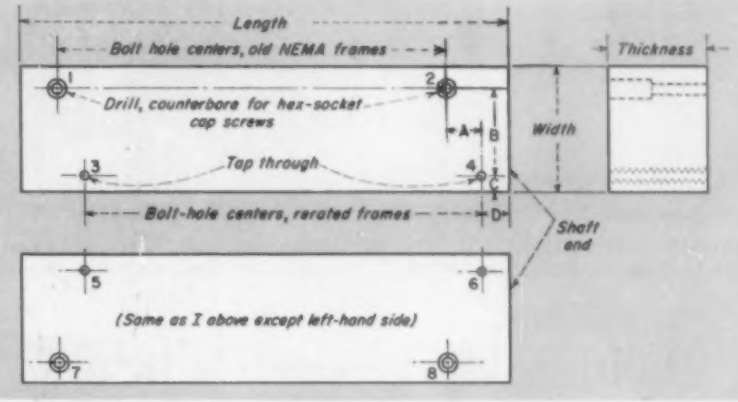
Diameters of rerated motors are about 13 per cent less, and lengths are about 11 per cent smaller. Although this change appears to be drastic, changes in standard dimensions apply only to mounting, shaft, and shaft-extension. However, the problem of interchangeability between motors of the same rating has appeared for the first time in 25 years, and universal changeover throughout the motor industry will require an appreciable time to complete.

In the new rerated line, shown in Fig. 2, a new smaller 180 frame size is introduced. Both 200 and 220 frame sizes have been discontinued, and a new intermediate 210 frame size is added. The 250 and 280 sizes remain, but

NEMA Frame Series		Hp Ratings				Motor Spacer Adapter Dimensions, in Inches												
									Bolt-hole Centers							Holes, 1,2,7,8		
Rerated	Old	3600 Rpm	1800 Rpm	1200 Rpm	900 Rpm	Length	Width	Thickness	Old NEMA	Rerated NEMA	A	B	C	D	Tap size, holes 3,4,5,6	Drill	Counterbore Dia	Counterbore Depth
182†	203	1.5	1	3/4	...	7-9/16	2	1/2	5-1/2	4-1/2	1/2	1/4	1-1/8	11/16	3/8-16	13/32	5/8	25/64
182†	204	...	...	...	1/2	8-5/8	2-1/2	↓	6-1/2	↓	↓	↓	1-3/8	3/4	↓	↓	↓	↓
184†	204	2	1-1/2	1	...	↓	2	↓	↓	5-1/2	↓	↓	1-1/8	↓	↓	↓	↓	7/16
184†	224	3	2	1-1/2	3/4	9-7/8	2-1/2	1	6-3/4	↓	1-1/2	3/4	↓	↓	↓	↓	↓	↓
213††	225	5*	3*	2*	1*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
213	254	..	...	...	1-1/2	11-1/4	2-1/2	1	8-1/4	5-1/2	1-1/8	3/4	1	7/8	3/8-16	17/32	13/16	9/16
215	254	7-1/2	5	3	2	↓	↓	↓	↓	7	↓	↓	↓	↓	↓	↓	↓	↓
254U	284	10	7-1/2	5	3	12	3	3/4	9-1/2	8-1/4	1/2	1/2	1-5/8	1-1/8	1/2-13	↓	↓	↓
256U	324	15	10	7-1/2	5	15	3-1/2	1-3/4	10-1/2	7	2-1/8	1-1/4	1-7/16	↓	↓	21/32	15/16	11/16
284U	326	...	15	10	7-1/2	14-7/8	↓	1	12	9-1/2	1/2	3/4	1-1/2	↓	↓	↓	↓	↓
286U	326	20	...	...	...	↓	↓	↓	↓	11	↓	↓	↓	↓	↓	↓	↓	↓
286U	364	...	20	...	10	16-1/8	↓	2	11-1/4	↓	1-7/8	1-1/2	1-1/8	1-5/8	↓	↓	↓	↓
286U	364S	25*	...	...	...	14	3-1/2	↓	↓	↓	−1/2§	↓	1	↓	↓	↓	↓	↓
324U	364	...	25*	15	...	15-1/8	3	1	↓	10-1/2	5/8	3/4	1-1/8	1-7/8	5/8-11	↓	↓	↓
324U	364S	30	...	...	...	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
324U	365	...	25**	...	...	16-1/8	3-1/2	↓	12-1/4	↓	↓	↓	1-1/2	↓	↓	↓	↓	↓
326U	365	...	30*	20	15	↓	↓	↓	↓	12	↓	↓	↓	↓	↓	↓	↓	↓
326S	365S	40*	...	...	...	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
326U	404	...	30**	...	...	17-5/8	4	2	↓	↓	2-1/8	1-3/4	1-1/4	↓	↓	13/16	1-1/16	13/16
326S	404S	30†	...	...	...	↓	↓	↓	↓	↓	1-7/8	↓	1	↓	↓	↓	↓	↓

* Open rating.
** Totally-enclosed fan-cooled rating.
† Ends of shaft extensions of 182 and 184 extend 1/8 in. beyond 203 or 204.
†† When 213 is installed in place of 225, and 324U in place of 365S, drilling and tapping of additional holes are required because of coinciding base holes.
§ Holes 2, 8 are located between holes 4, 6 and shaft end of spacer bar.

Fig. 4—Dimensions of metal spacer bars used to provide interchangeability of old and new ratings. Use of these bars compensates for differences in shaft height and position and also for variations in mounting bolt-hole dimensions for foot-mounted motors.



in both cases an additional longer frame is added. The 320 size continues with the same frame lengths as originally. In every case where frame sizes have not changed, more horsepower is contained in that frame size, and a larger shaft diameter is provided.

A comparison of mounting and shaft dimensions of 1800-rpm foot-mounted motors is shown in Fig. 3. Shaft height is reduced in all cases, ranging from $\frac{1}{4}$ to 1 in. Shaft diameter is unchanged in about one third of the ratings, is increased in another third, and decreased in the remaining ratings.

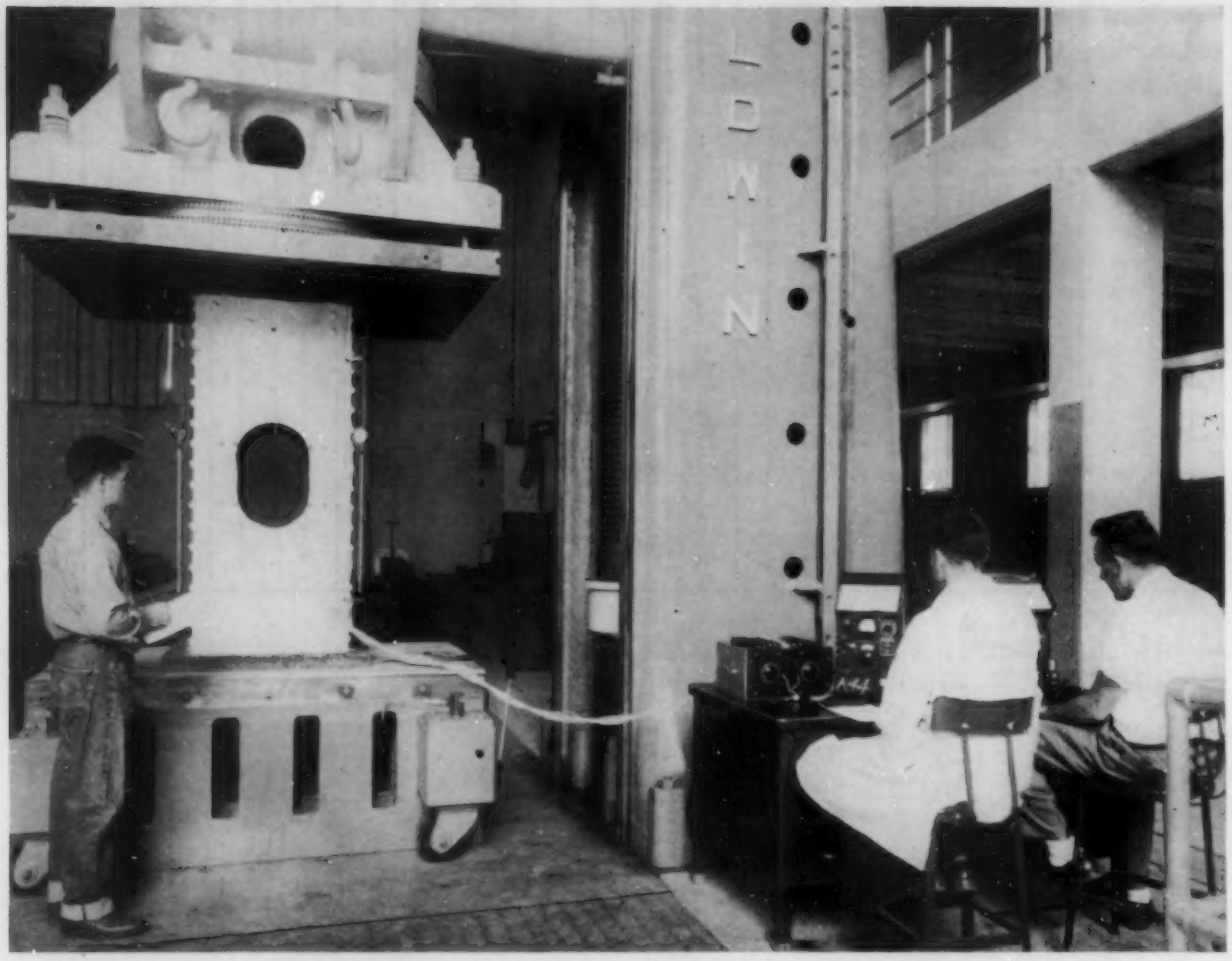
Spacer Bars for Interchangeability

In order to provide for interchangeability of old and new ratings, rerated motors must be raised until shaft centerlines coincide with the old rating. The new motor must be positioned axially so the end of the shaft extension coincides with the position of the old. Mounting-hole locations also will necessarily be changed. These three problems are simultaneously solved by use of metal spacer bars shown in Fig. 4.

Since the shaft diameter has been changed in two thirds of the new ratings, changes will have to be made in bores for couplings, pulleys, or gears. For undersized shafts it will be necessary to rebore, bush, and cut a keyway; for oversize shafts the coupling, gear or pulley must be rebored and a keyway cut. The shaft dimensions shown in Fig. 3 for 1800 rpm motors can be used to evaluate the problem. The same keyways are used for a given shaft in both ratings.

FOR FURTHER READING—"What the New NEMA Standards Mean", December 1953 page 144, discusses the significance of NEMA frame numbers and letter designations, and compares old and rerated frame sizes for open drip-proof, totally-enclosed fan-cooled and flange-mounted motors.

TECHNICAL NEWS



HIGH STRENGTH STEEL TEST SPECIMEN being subjected to a predicted load of 3,500,000 pounds. Base structure of 5,000,000 lb. machine can handle parts up to 100 ft. long, in flexure tests, and 40 ft. high in tension and compression tests.

Lehigh University Dedicates World's Largest Testing Machine

On October 14, 1955, Lehigh University dedicated the new Annex to the Fritz Engineering Laboratory, and with it the 5,000,000 lb. universal testing machine shown on the cover. Considering the load capacity and the size of tension, compression, and flexure specimens it can accommodate, the testing machine is considered the largest of its type in the world. It will test in tension and compression vertical specimens 40 ft. in length, and take beams or girders 100 ft. long in bending tests up to the capacity load of 5,000,000 pounds. This greatly exceeds the capabilities of any other machine. In addition, at lesser capacities, beams of 115 to 120 ft. can be tested.

Two similar machines of 5,000,000 pounds capacity are owned by the government. One at the Philadelphia Navy Yard handles tension or compression speciments 30 ft. long, while the one at the Bureau of Reclamation in Denver will take specimens up to 32 ft. in length. Now, columns, cables, or a complete 100 ft. plate girder type railing bridge can be tested to give results which up to now could only be estimated.

The Fritz Engineering Laboratory is the Civil Engineering Laboratory at Lehigh, and was founded in 1909. It was considered the best structural laboratory in the country, and had the 800,000 lb. Riehle screw-type universal testing machine. John Fritz, who was regarded as "the father of the steel industry," (founder of Bethlehem Iron Works, now the Bethlehem Steel Co.) was on the original board of trustees of Lehigh, and donated the funds and supervised the design and construction of the laboratory.

The 5,000,000 lb. machine was de-

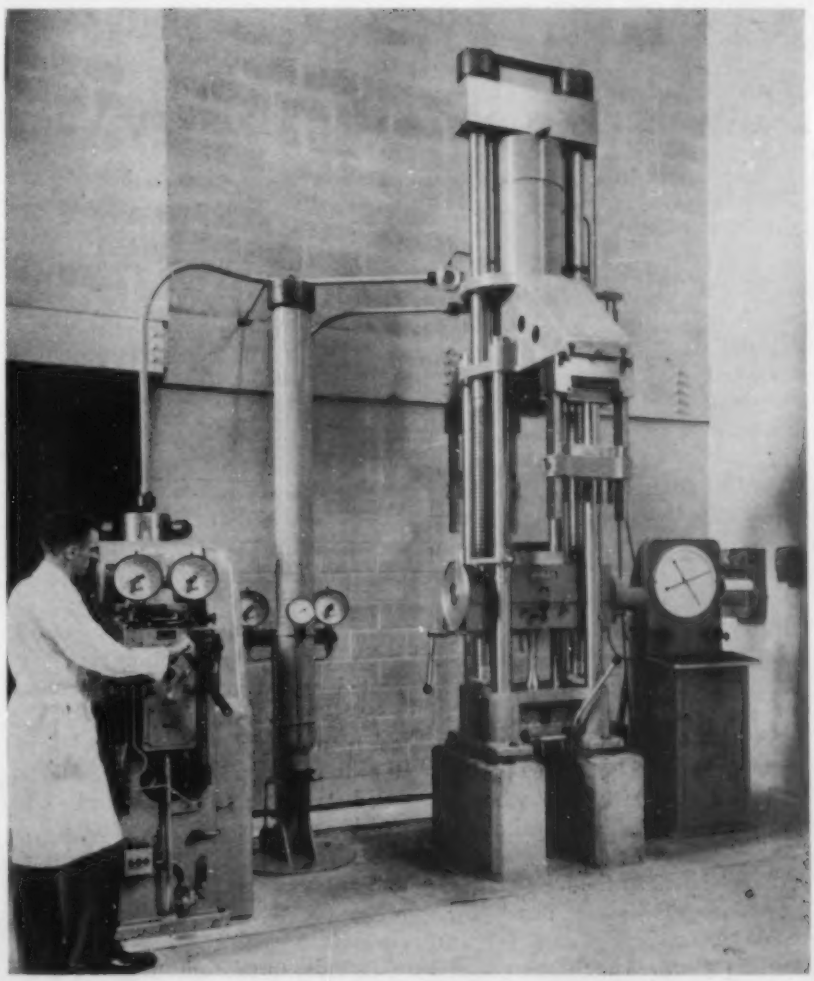
THE NEW FRITZ ENGINEERING LAB. at Lehigh University, has offices, laboratories, and classrooms, with huge center bay housing the large testing machine.

signed and built by Baldwin-Lima-Hamilton Corp. of Philadelphia, Pa. It is about 60 ft. high, with a 10 ft. clear space between the columns. Loads are applied hydraulically by a movable cylinder on a stationary piston 54 in. in diameter which is mounted at the base. Hydraulic pressure at maximum load is 2200 psi. The cylinder carries two vertical screws through which the loads are applied on the test specimens. The load-measuring system is hydraulic and completely independent of the loading system. Its guaranteed accuracy is within ½ per cent of the dial reading. Measuring scales can indicate load variations of 20 pounds.

Other facilities in the laboratory include a separate dynamic testing bed using Amsler equipment. This equipment is designed to apply and measure repeated loads of up to 100 tons at a rate of 250 to 500 cycles per minute, and will handle any shape specimen up to 14 ft. wide by 70 ft. long. Tension, compression, bending, torsional, or any combination of these can be applied.

A 2,000,000 in.-pound torsion machine, plus smaller tension, compression, torsion, impact, and hardness testing machines are also available. There are special concrete, hydraulic, materials testing, soils mechanics, and sanitary engineering laboratories for research and testing.

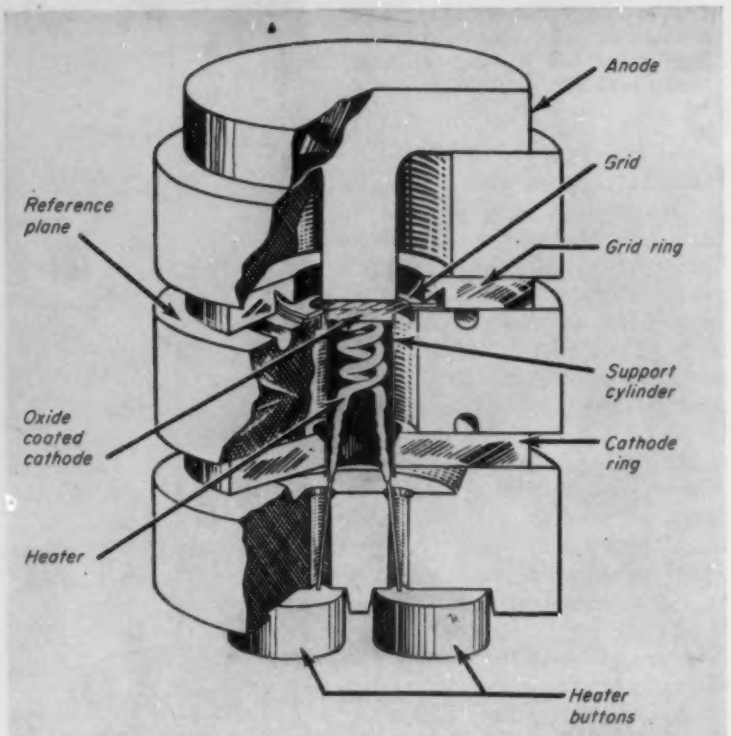
Recent test work at the laboratory has been on: full sized welded connections for building construction; crane girders during actual operation to measure stresses due to impact; tests of stresses in crane ladle hooks and hot metal ladles; and tests on thin shell roof structures. At present, research programs in prestressed concrete, and the design of welding continuous structures are under way.



THE AMSLER alternating stress machine, a European test device just introduced in this country, is installed in the new laboratory. Here it applies tension of 20,000 to 140,000 lb. at 250 times per minute to a steel test specimen. Capacity of the equipment is 200,000 lb. at the rate of 250 to 500 cycles per minute.

BRACELET CHARM SIZE, General Electric's new titanium and ceramic electronic tube will be used to improve UHF television reception.

SIMPLE CONSTRUCTION of the tube uses alternate ceramic and metal (titanium) components. Key to this new method of this construction is the use of a ceramic reference plane from which the active elements of the tube are located. The tube will stand severe vibration and shock conditions. Using a ceramic having roughly the same expansion and contraction characteristics, plus special sealing techniques will keep the tube vacuum-tight at temperatures over 1300 F.



G-E MICRO-MINIATURE CERAMIC TUBE, TYPE 6BY4

New Trends and Materials in Vacuum Tubes

The tiny barrel-shaped object shown here is General Electric's 6BY4—a triode designed for UHF television tuners and converters. Made of white ceramic and titanium rings sealed together, G. E. claims that it will amplify UHF television more effectively than any existing receiving tube; but more important, that it indicates a completely new type of tube design from diodes to complex multi-element tubes. Possible applications include mobile and industrial communications, airborne and mobile radar, industrial controls, guided missile controls, and nuclear power controls.

The micro-miniature tubes of this design will withstand operating temperatures better than 950 F, and in tests, the tubes have operated at this temperature for more than 500 hours. At present tests are under way to check the tube's ability to take vibration, impact shock, and centrifugal acceleration.

All metal parts of the tube are made of titanium, which was found to be capable of absorbing gases rather than liberating them. The titanium parts are degreased and then heated in a vacuum at a temperature beginning at 950 F. As the temperature is increased, the gases are pumped off. This process is continued until a temperature of 1950 F is reached. It was discovered that after titanium had been heated for a short time at 1300 F, no further gases were given off, even when the temperature was raised or lowered. This is in contrast to other metals which continue to give off quantities of gas at successive temperature increases until the metals reach their melting points.

This low temperature at which titanium can be degassed makes it valuable for use in tubes using oxide-coated cathodes. Once a cathode has become active, it is harmful to the emission if any gas is liberated from the tube parts. Titanium also has good gettering properties, and will quickly clean up large amounts of the gases commonly present in vacuum tubes. This is sometimes true even when the titanium is at room temperature.

In order to take advantages of these good properties, G. E. then developed a ceramic whose thermal expansion and contraction characteristics were practically the same as those of titanium. The result was a ceramic insulating material which can be heated to high temperatures without liberating appreciable amounts of gas.

The ceramic tube is simply constructed so that the circuit is connected to the electrodes through metallic disks. This makes possible low inductance connections to the cathode, grid, and plate, and little of the amplified signal is lost. The two end buttons are the heater connectors. This miniature construction results in low capacitance, which was one of the prime objectives of the entire development.

The heated cathode is supported on a thin cylinder of metal which acts as a low inductance connection to the cathode ring, and isolates the oxide coated cathode thermally from the external circuitry. The grid is spaced from the ceramic reference plane by a spacer which gives 0.0006 in. hot spacing between the grid and the cath-

ode. The grid is made with 0.0003 in. diameter tungsten wire wound at 1000 turns per inch.

The new 6BF4 ceramic tube with its 15 to 17 db of power gain and approximately 8.5 db noise figure at the top of the UHF TV band will improve fringe area UHF television reception. However, of greater importance is the tube's basic structure which is going into tubes now being designed.

Metal Notes . . .

• **Aluminum.** The Anaconda Aluminum Co. has revealed that it has developed a process for producing aluminum from domestic clays and plans to get into production by 1957. Anaconda has requested enough natural gas to operate the clay processing plant, located in the Pacific Northwest. It has been estimated that from 25 to 40 million cu. ft. of gas per day will be required to reduce the clays to alumina, usually obtained from bauxite.

• **Titanium.** Harvey Aluminum is now fabricating titanium alloy extrusions on a production basis. Sections are being extruded in lengths from 10 to 12 ft. in alloys 4Al-4Mn, 3Al-5Cr, 3 per cent complex, 6A1-4V, and 5Al-2.5Sn. Entire production is headed for airframe manufacturers.

• **Uranium.** Sound uranium ingots are being produced by melting "derby" uranium with the consumable electrode arc-melting process at the Atomic Power Div. of Westinghouse. The process is clean and easy to control, and without primary or secondary pipe, or any shrinkage cavities.

• **Aluminum** Increased copper prices as well as shortages of the metal have caused the Western Electric Co. to initiate a program aimed at the substitution of aluminum in telephone cable. Western Electric uses about 100,000 tons of copper a year. Based on 1946 figures, copper prices have shot up 258 per cent, while aluminum has increased only 63 per cent.

• **Titanium.** The National Lead Co. has discovered large deposits of Titanium on its properties in Tahawus, Essex County, N. Y., in Norway, and by purchasing of large tracts of titanium bearing land in Northern Florida. Deposit in N. Y. is estimated to hold more than 100-million tons.

Non-Tracking Organic Insularion Developed

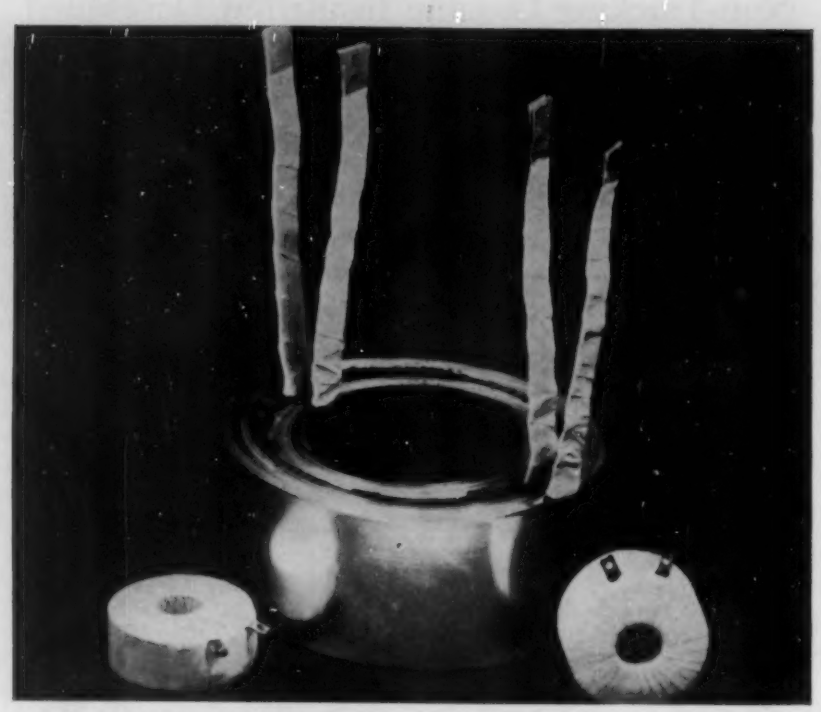
"Carbon Tracking," the result of exposure to electric arcs and the bogy of all organic electrical insulating materials, has been overcome with the announcement of Hy-Bute/60, General Electric's new outdoor insulating material. G. E. feels that this material now will make possible the construction of instrument transformers for outdoor applications at 15 KV and above under the most severe atmospheric conditions. It means the elimination of oil-filled metal casings, porcelain bushings and gaskets, resulting in a lighter transformer that will need little maintenance. In addition, there can be no explosion or fire hazard. Use of organic materials such as ordinary butyl for outdoor insulation has up to now been limited to lower voltages, because they could not take the high electrical discharges.

• **What to Watch.** Of particular interest is that the specific additive which gives these characteristics is not limited to butyl rubber alone. G. E. has found the additive to be equally successful when used with phenolics, polyester, and epoxide resins, which should affect greatly the future design of all types of electrical equipment. However, the company at present is concentrating on Hy-Bute/60.

To make these materials non-tracking requires only a small amount of G. E.'s special additive to the basic plastic or rubber during the compounding operation. The additive does not significantly change the appearance, the dielectric strength, the mechanical properties of the base materials, nor the price. When the material using the non-tracking additive is subjected to severe surface sparking, the additive starts an oxidation reaction in which the gaseous oxides of carbon are formed. No free carbon is formed on the surface.

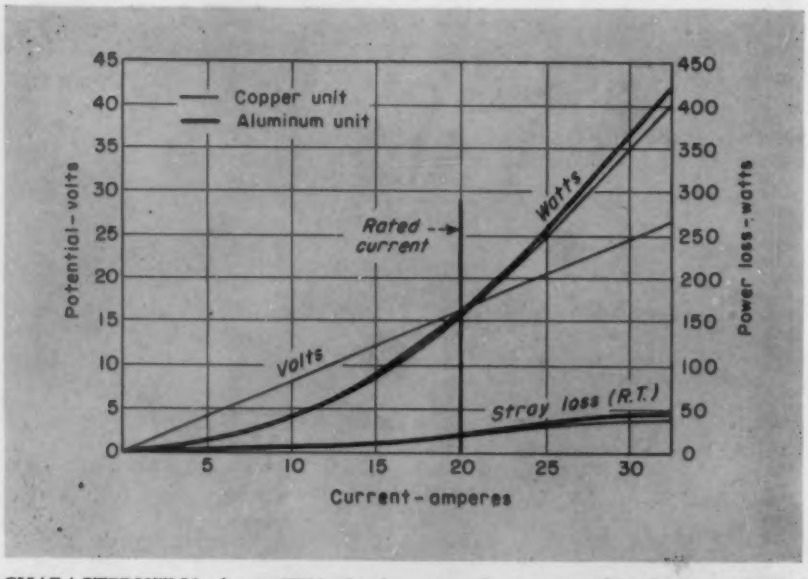
In tests conducted in extreme salt-fog atmosphere (see illustration), the new modified butyl rubber showed no ill effects after several thousand hours. Under the same conditions, porcelain insulations disintegrated in less than 100 hours as a result of thermal shock caused by sparking.

CURRENT TRANSFORMER, insulated with a new non-tracking, butyl rubber material, is being removed from salt-fog test chamber after 1400 hours at full voltage. New additive is being tested with phenolics, polyester, and epoxide resins.



LARGE COIL WOUND with new anodized aluminum strip conductor is for 10 KVA transformer. The anodizing serves as an insulating material. Smaller contactor coils are wound with bare aluminum foil and polyester film insulation.

Aluminum Foil Replaces Wire In Coil Winding



CHARACTERISTICS of a 10 KVA aluminum transformer wound in the same physical size as a square copper, double glass insulated unit. Result is almost identical electrical characteristics with half the weight. Exact prices for the coils have not been quoted, as yet, but with copper 15-20 cents more per pound than aluminum, Reynolds figures that it has a good market. Use of this material is not limited to transformers.

Aluminum is making further inroads into the electrical field, with the announcement by the Reynolds Metals Co. that it is winding coils with strips of aluminum foil instead of with the conventional wire. With this new method, Reynolds expects the cost of coils used in transformers, solenoids, and some motors to be substantially reduced. Further, the aluminum coil weight is about one-half that of a comparable copper unit.

Key to the new winding technique is an anodic coating built up on the aluminum strip to a thickness of from 0.0001 to 0.0003 inch. This anodic film serves as an insulation for the strips wound into a coil, and replaces the paper, glass or other insulation normally used with wire coils. In addition, with the melting point of the aluminum oxide 3,600 F, the windings are not limited to the temperature rise normally associated with organic insulations. Of interest are the good heat dissipation characteristics connected with this type of winding. As each turn of the coil is exposed to the outside of the coil, it eliminates the hot spots inside, as well as the cooling ducts usually left in the interior for the elimination of heat.

The use of anodized film on magnet wire has been considered for some time, but with wire there are drawbacks. The anodized film is not ductile and cracks when the wire is bent, causing extrusion of metal through cracks on the inside radius. By changing to an anodized strip, this crazing is greatly reduced. Also, the flat strip eliminates the voids left by round conductors.

Reynolds has one particular application in mind for this type transformer—that used at each home. With the increased consumption of power in each house, a transformer placed in each home would step the voltage down from 480 to 240 and 120 volts, without larger distribution conductors. A 3 to 7 KVA unit would be used.

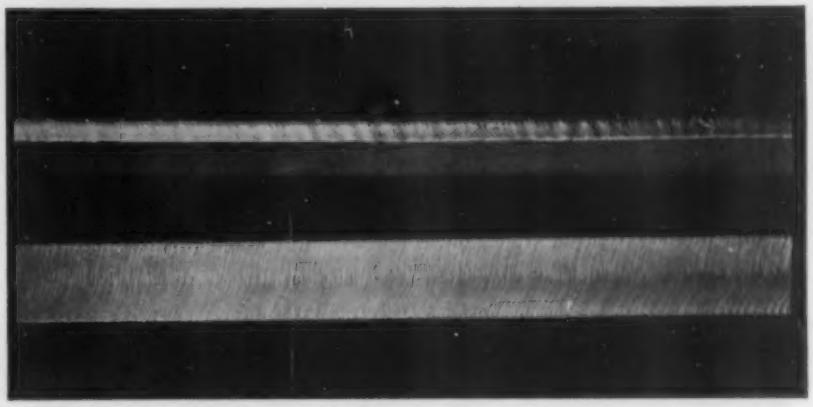
Small transformers using this technique are already being adapted for aircraft use. Reynolds also said that the anodized strip could be used in oil-filled transformers as well, but that the temperature of the unit would be limited. However, the anodized strip cannot be used without further insulation for power type capacitors.

High-Speed Cutting of Non-Ferrous Metals

Something new in the light metal fabrication field is a gas-shielded arc process for the high speed cutting of non-ferrous metals. Nonexistent in the nonferrous metal field up until now, the new process will cut ¼ in. aluminum plate at a rate of 300 in. per minute, while producing a smooth, saw-like cut.

Called Heliarc cutting and developed by Linde Air Products Co., Div. of Union Carbide & Carbon Corp., the process employs a very high temperature, high velocity constricted arc between a tungsten electrode and the piece to be cut. The arc stream removes the molten metal, and the gas atmosphere prevents oxidation of the cut face. As the Heliarc process is adaptable to mechanized or manual operations, it can be used for curve, circle, and pattern cutting, as well as straight line, edge, and level cutting. Until now, band saws and planers have been used for cutting or edge preparing of non-ferrous metals, but for the most part have been limited to straight-line cuts.

Cutting speeds of aluminum using mechanized process, are: ¼ in. material, 300 in. per min.; ½ in. material, 125 in. per min.; ¾ in. material, 75 in. per min.; and 1 in. metal, 50 in. per minute. With manual cutting, the speed is about 60 in. per minute. Linde compares these figures to those in the fabrication of aluminum tank cars made of ⅜ in. plate where the average hand-cutting speed is about one inch per min. using a combination of burning and chipping, or drilling and chipping. With a planer, including set-up and handling time, the speed is about 10 in. per minute.



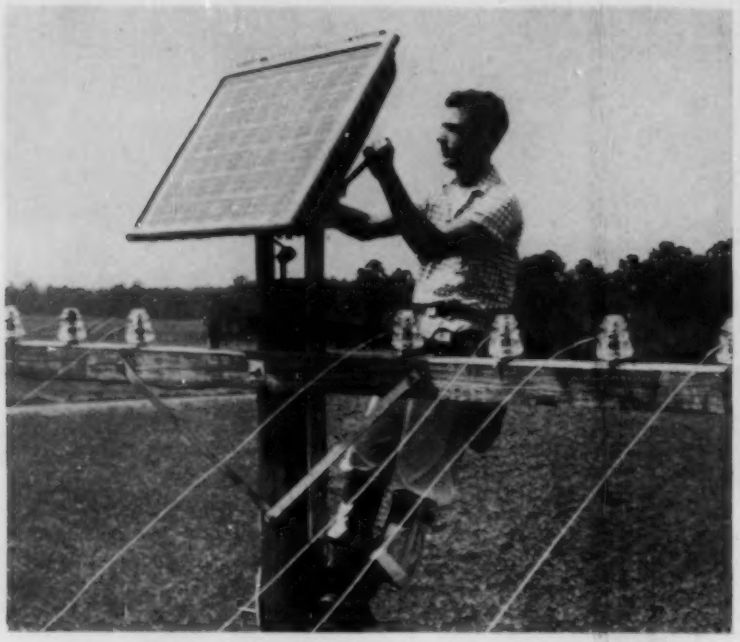
AFTER CUTTING with the new Heliarc process, the edges of these aluminum pieces look like this. Top piece is ¼ in. thick, and was cut at a rate of 300 in. per min., using 320 amp. and 70 volts. Bottom piece is one-inch thick, and was cut at 50 in. per min., using 320 amp. and 80 volts.

MANUAL CUTTING OF ALUMINUM. Design of torch is only slightly different from that used in Heliarc welding. A new collet and collet body have been made, plus a different type of nozzle with a replaceable insert. An electric circuit called the "pilot-arc" circuit, which initiates the cutting arc, has been added. A resistor in this circuit limits the current from the power supply to the nozzle.

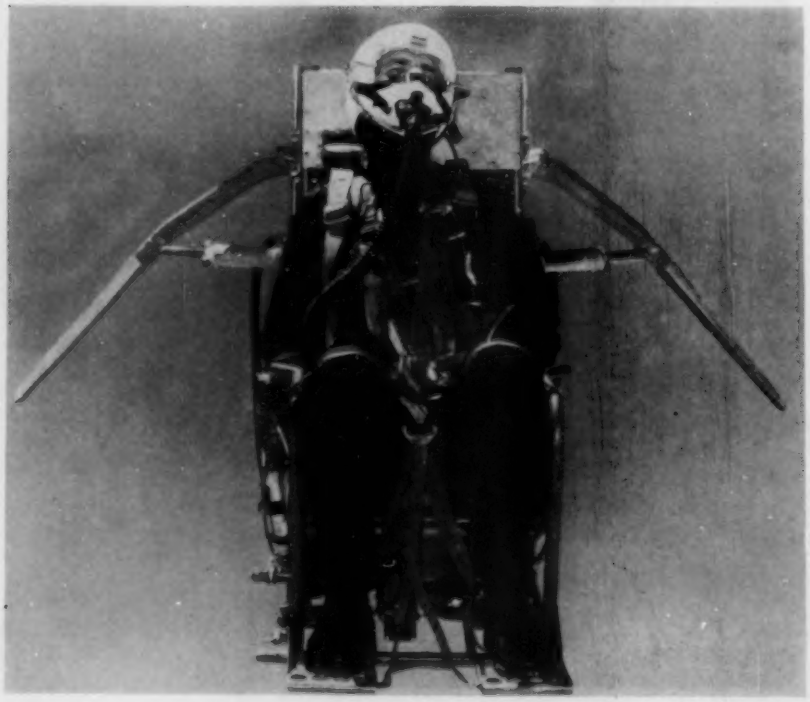
• **Arc Starting.** Two methods are used with the new process. In mechanized cutting, a standard high-frequency unit is used with the pilot circuit to initiate the cutting arc. In manual cutting, a pilot arc in an argon atmosphere is used for starting the cutting arc. It was found that the strength of the high-frequency unit had an influence on the reproducibility of starting when long arc lengths were used. Good starting was obtained using a nozzle-to-work distance of about ¼ inch. Also, the initial impluse of the high frequency unit must contact the edge of the plate to get reliable starting. Experiments have shown that best results are obtained when using a mixture of 65 per cent argon and 35 per cent hydrogen for mechanized cutting. With this mixture a high arc voltage is developed.

With manual cutting, the best mixture is about 80 per cent argon and 20 per cent hydrogen. The lower hydrogen provides a greater tolerance for variation in arc length. Here pure argon is used for initiating and maintaining a pilot arc, before the starting of the cutting arc.

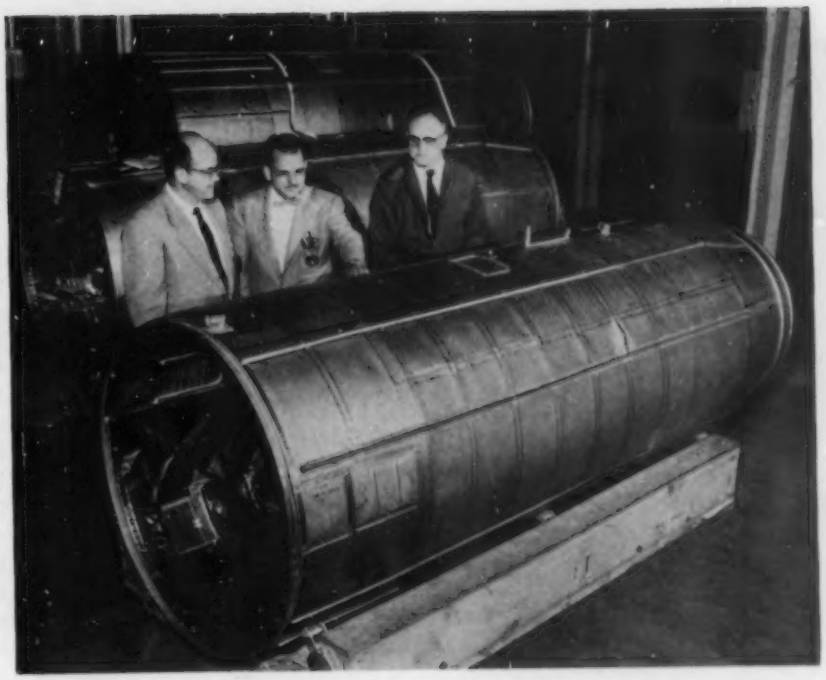
THE NEWS IN PICTURES



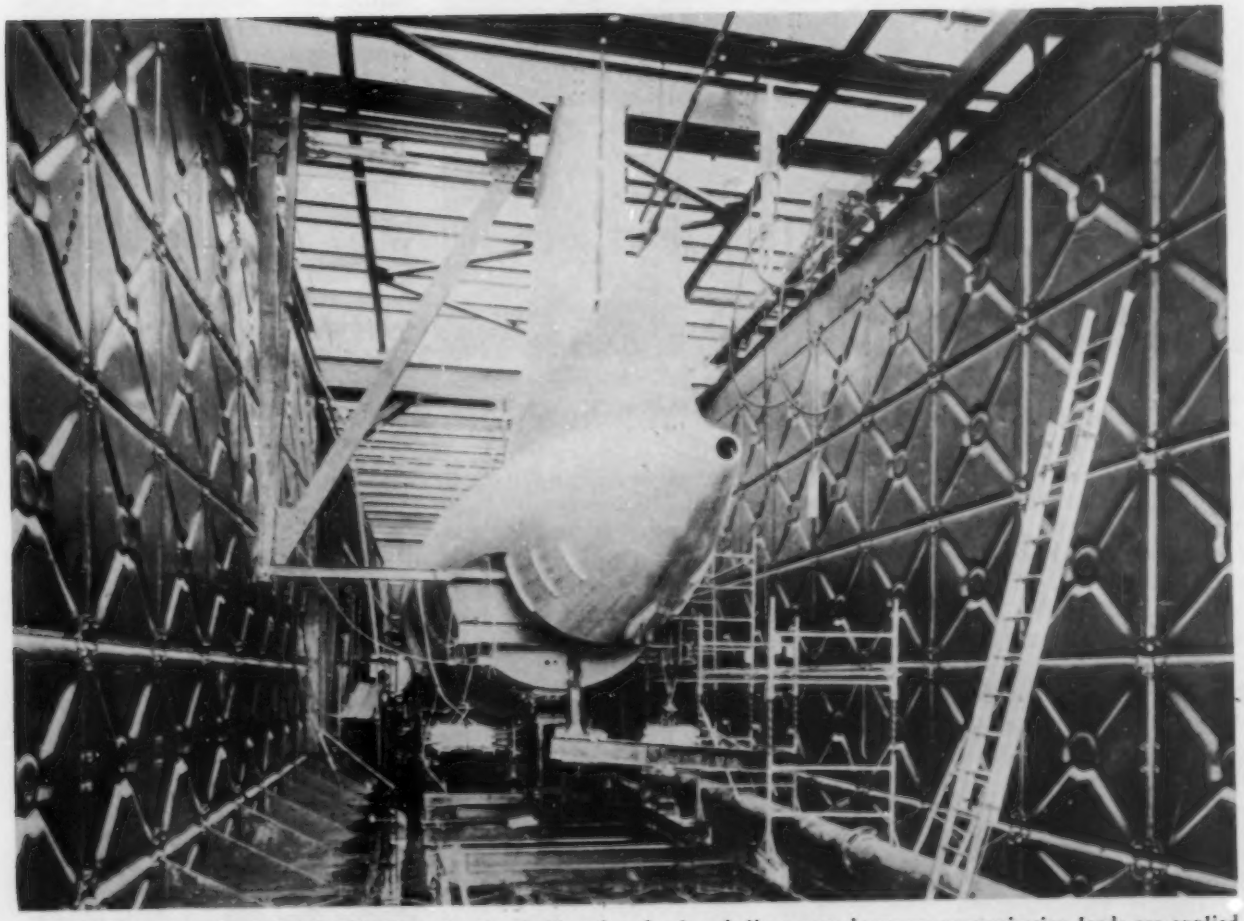
BELL TELEPHONE'S SOLAR BATTERY being used near Americus, Georgia, in a series of experiments to develop more and better rural telephone service. The battery shown here is encased in an aluminum housing less than a yard square. It contains 432 silicon cells, cushioned in oil, and covered by glass. The cells can convert up to 11 per cent of the sun's energy directly into electrical power, and can deliver power at the rate of 100 watts per sq. yard of effective surface. Excess current from the solar unit not needed for immediately telephone use feeds into a storage battery (above) which provides power at night and over periods of bad weather. Even in poor light, the solar battery will charge the storage battery, but at a lower rate. This new system uses transistors instead of vacuum tubes, plus the "carrier" principle which allows several conversations to be sent simultaneously over a single pair of wires. Each conversation is sent at a different frequency.



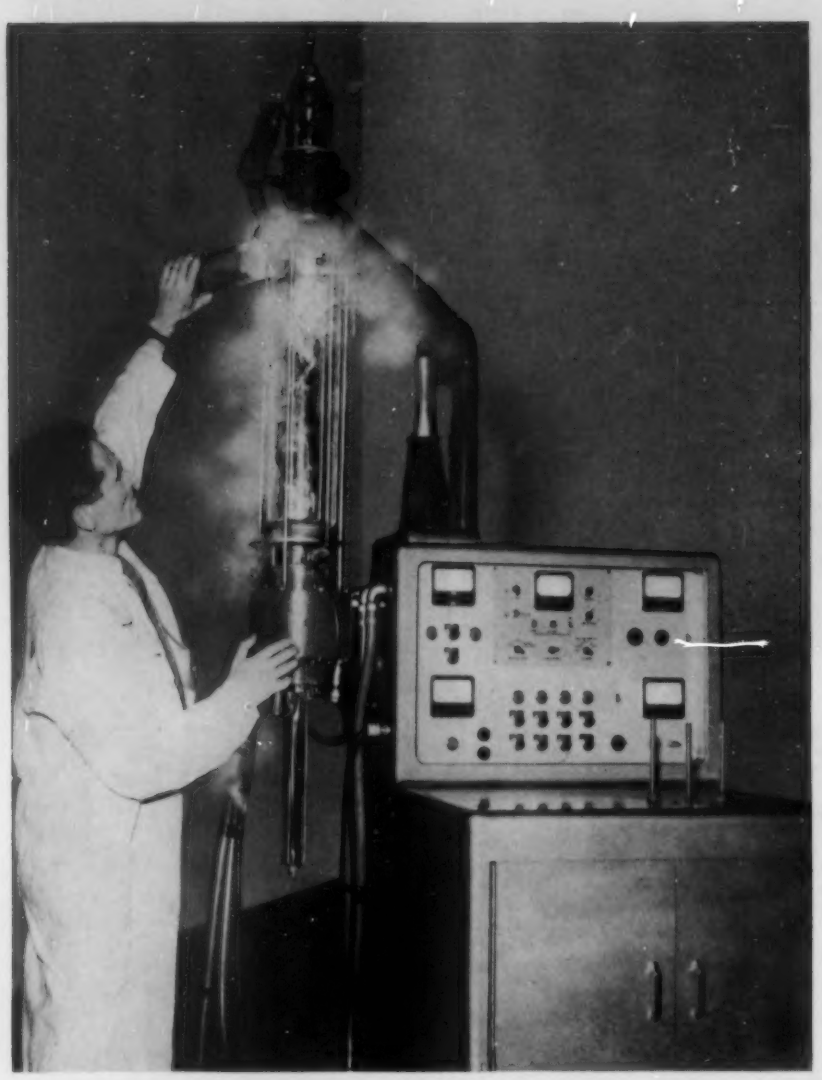
LOOKING LIKE HE HAS HIS OWN FLAPPERS, this latest method of emergency escape permits a high altitude abandonment of a supersonic aircraft. The seat is ejected downward, and is stabilized in an upright position by the two fins. The pilot rides the seat down to 15,000 ft. where the seat is detached and the pilot drops the rest of the way by parachute At a lower altitude the pilot and chute are cleared from the seat within three seconds. Design of ejection seat is a result of tests of a full-sized seat on a high speed track at Edwards Air Force Base. Seat also contains the plane's complete oxygen system which stays with the pilot until he is detached from the seat. A special oxygen quick disconnect fitting, using permanent magnets to give a firm seal, was designed when wind tunnel tests showed that the standard fittings could not carry the high air loads.



SHROUDS OF TITANIUM used to cover and insulate the engine of Convair's F-102A Air Force interceptor from the rest of the fuselage. Until now, shrouds have been made of a smooth sheet titanium (background) that was subject to wrinkles. A dimpled, stronger surface is now used, and is thinner than the sheet titanium used previously. Seam and spot welds are used, eliminating rivets, for a further weight reduction. The F-102A will be the first plane in which the new material is used.



THE INSIDE OF THE WATER TANK at the Royal Aircraft Establishment at Farnborough, England. Last year a model of the ill-fated Comet was tested here to determine the cause of numerous crashes. Tank is made of 4 ft. square steel panels bolted together, and holds 250,000 gallons. It is a standard fuselage balloon test; however, pressurization loads are applied to duplicate in-flight conditions. Specially fitted holes permit the wings to extend outside where hydraulic jacks apply wing loads. Shown here is the fuselage of the Bristol Britannia, a plane to be used on BOAC's North Atlantic route.



Temperatures Maintained Near Absolute Zero

Claimed to maintain lower temperatures than any previous apparatus, this new-type refrigerator gets to within a few tenths of a degree of absolute zero (−459.6 F). Quite a departure from ordinary systems, this machine has no moving parts nor flowing fluids. Instead, it uses a plastic capsule 3 in. long, which contains a special chemical salt (a para magnetic substance of iron sulphate, or a variety of other sulphates are used) as a refrigerant. Operation of the device is controlled entirely by external magnetic fields, and is based on the cyclic principle of magnetic cooling as originated by Dr. John G. Daunt and Dr. Clifford V. Heer of the Ohio State University.

This principle—that certain materials will warm up when magnetized and cool when demagnetized—has been used for several years, but this apparatus is said to be the first that has been able to maintain the low temperatures for long periods of time. Previous equipment would warm up right after the temperature was reached. In illustration, refrigerated space is thin tube.

Made by Arthur D. Little, Inc, 30 Memorial Drive, Cambridge, Mass., the magnetic refrigerator is regarded as the first commercial application of the phenomenon called "superconductivity." This is a change that some metals undergo at very low temperatures, and lose all resistance to electric current. At the same time, metals in the superconducting state act essentially as thermal insulators, but conduct heat easily when not showing the superconducting effect.

Manufacturers Too Talkative

The Pentagon still feels that too much talk by industry is aiding the enemy.

The latest edict from Sec. of Defense Wilson is that all companies producing items for the Armed Services should be careful about making public any economic and technical information, even though it bears no military secrecy label. Mr. Wilson said that while such data may be unclassified from the military standpoint, it could be assembled into a pattern that would help the enemy measure this country's strategic intentions.

Management should be encouraged by the Armed Services to exercise caution prior to the release of such unclassified information in press releases, advertisements, notices to stockholders, brochures and annual or quarterly reports. Specifically, information about contract awards, vulnerable points in a plant, details of plant expansion plans, production methods, production rates and capacity, sources of power and other utilities, research and development data, and plant security measures.

Briefs

A patent for making refractory electrical contacts in a new way has been granted to G. L. Williamson of the Gibson Electric Co., Pittsburgh, Pa. The refractory materials used in the contacts are tungsten, molybdenum, or their carbides. The new process involves pressing powdered refractory material into a briquette, sintering the compressed material, placing silver in contact with one face of the briquette and putting a weldable metallic ferrous backing in contact with one face of the impregnating conducting material. The assembly in then placed in a furnace; simultaneously impregnating the refractory material with the conducting material, and bonding the backing to the impregnated contact. Mr. Williamson says that the new method is less costly, less time-consuming, and more effective than other methods of making contacts for spot-welding.

New Stainless steel alloys made with manganese instead of nickel have been

announced by Allegheny Ludlum Steel Corporation. The continuing shortage of nickel has forced this move. The latest sheet and strip alloy available has a composition of 17 per cent chromium, 4 per cent nickel, and 6 per cent manganese. This alloy has the high strength, corrosion resistance, and formability of the type 301, 17 per cent chromium, 7 per cent nickel material. The AL 17-4-6 has been assigned AISI type 201. Another stainless nickel saving alloy has 18 per cent chromium, 5 per cent nickel, and 8 per cent manganese. Called AISI type 202, it is an austenitic alloy developed as an alternate for type 302. Manganese reduces the resistance to oxidation at high temperatures; therefore, type 202 is not recommended for applications above 1500 F. Research on other alternates is underway.

Big Wind at University of California

Operation of the world's largest supersonic, high altitude wind tunnel will permit the study of objects traveling more than six times the speed of sound at from 20 to 80 miles above the earth. This is higher than man has ever "flown" in the laboratory. The new wind tunnel is located at the University of California's Engineering Field Station in Richmond, Calif., with the support for the research coming from the Office of Naval Research, the National Advisory Committee for Aeronautics, the Office of Scientific Research, and the Air Research and Development Command of the U. S. Air Force.

• **How it Works.** The tunnel is 20 ft long and three feet in diameter, and consists of two vacuum chambers separated by a tapered nozzle 6 in. in diameter. It is at this point that the supersonic air flow is produced. Two large steam ejector vacuum pumps powered by a 350 hp. boiler pull air through the nozzle, (where the test models are located) at the rate of 50 lb. per hour.

The vacuum pump maintains a pressure of 1/100 of an atmosphere in one chamber, and 1/10,000 of an atmosphere in the other. This difference in pressure produces the continuous supersonic flow of air through the nozzle. The tunnel is different from other wind tunnels in that it has no large fans to blow air at supersonic speeds over the models. However, these fans cannot simulate the high altitudes possible with the new vacuum wind tunnel at the Univ. of California.

It was learned that a projectile flying at many times the speed of sound gets hotter at very high altitudes than it does when flying at a low altitude. This was unexpected because the heat producing forces of dense air at low altitudes are greater than in rarified atmosphere. This was explained recently when it was found that thin air is more viscous than air masses at low altitudes, and that the heat caused by friction in the stratosphere cannot be conducted away as easily.

It is expected that the speed of the supersonic air stream will be increased in future tests. This will permit the use of larger nozzles, and consequently larger test models which will yield more refined data.

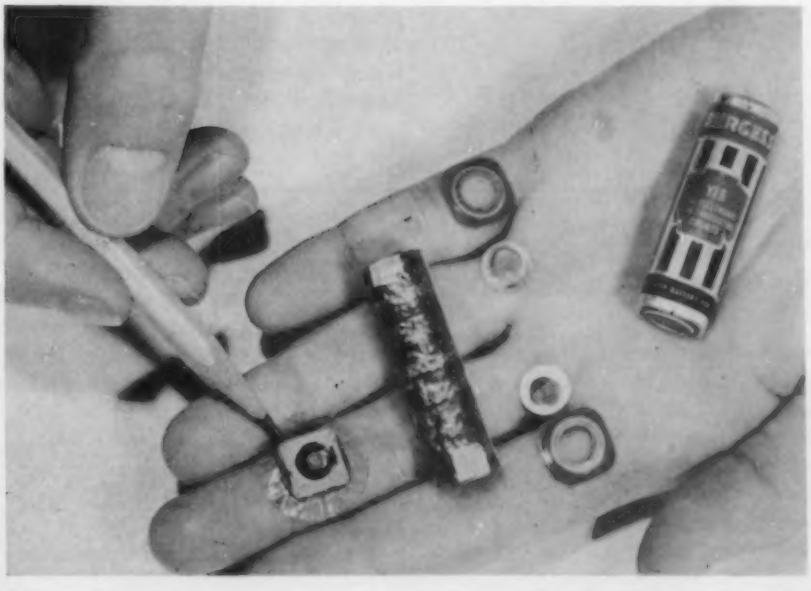
Small, Powerful Wafer Cell Used in Dry Batteries

The "wafer cell," Burgess Battery Co.'s new sandwich of artificial manganese dioxide mix between small disks of flat zinc and carbon electrodes, is making possible a 30 per cent increase in battery power life, while eliminating many hand operations from cell manufacturing. The cell is a third more powerful than conventional flat cells, is made entirely by machine, and is sealed in an pliofilm envelope, and heat sealed. By stacking 13 of these cells in a column (see photo), wrapping in plastic, and sealing in a leakproof aluminum tube, it produces the 22½ volt battery at right.

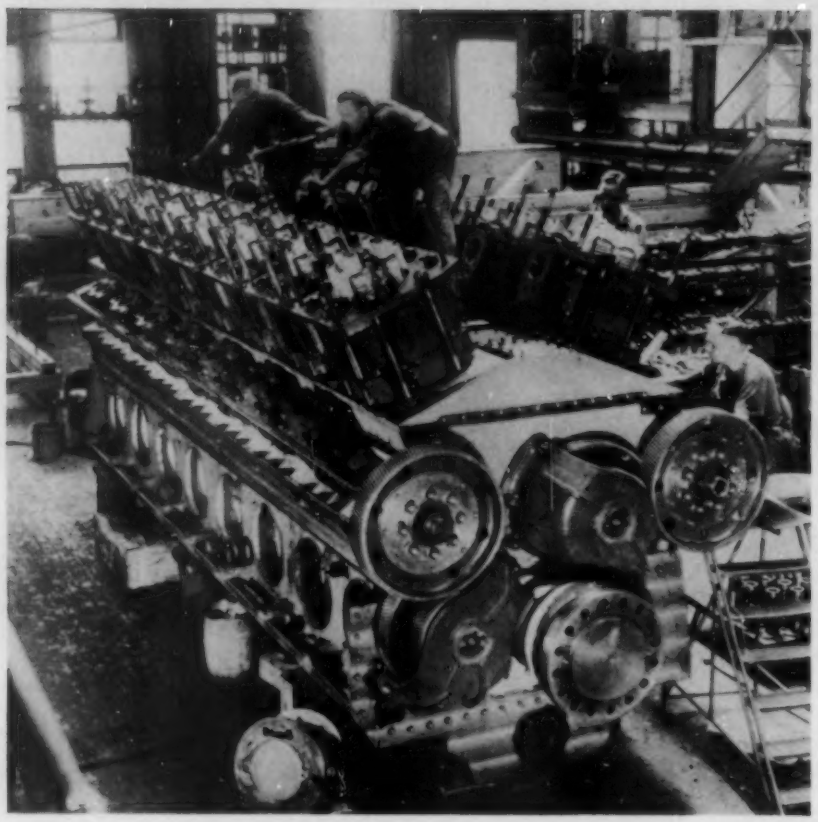
Welded or soldered wire connections are not necessary because of a new conductive silver wax intercell connection developed by Burgess. The wax is applied to the positive and negative sides of the cell before it is stacked in a column. The wax will yield and mold itself to any shape between the cell necessary to make an electrical contact. As an example of small size, the U200 battery made from the cells provides over 300 v in less than 20 cu. in. of space.

In the 22½ v model, mylar film is used as the insulating cell stack wrap instead of paper tape. Features of the wafer cell are: elimination of leakage between cells; good inter-cell connections; and the ability to age and test each cell individually before it is used in completed batteries.

The batteries will be used in hearing aids, pocket radios and recording devices, geiger counters, photo flash cameras, and transistor circuit electronic instruments.



TECHNICAL NEWS



Low-Speed, High Pressure V-Type Diesel

Worthington Corporation's new 16-cylinder V-engine, which will develop twice as much power as present diesels of the same weight and dimensions. Known as the SW-14 line, the engine is a high pressure turbo-supercharged, four-cycle design rated from 1360 to 5000 hp at 450 rpm. The engine is claimed to be the only low speed high pressure engine in the U. S. designed for a capacity exceeding 200 psi bmep. Engine is available in 6, 8, 12, and 16 cylinders.

Feature of the SW-14 is its interchangeability of major parts between the in-line and the V-engines, such as cylinders, heads, rods, pistons, bearings, and fuel injection equipment. User will not have to stock different spare parts to service both engines. Engine also has a 5-inch heavy camshaft, and removable cylinder liners with cast-in water jackets. Discharge pressure is 8-10 psi. permitting a small air after cooler and reducing cooling water requirements. Engine can be used as oil diesel, dual fuel diesel, or spark ignition gas.

New Muffler Uses No Baffles

In an attempt to cut down the back pressure caused by conventional type automotive mufflers, E. J. Hall of Australia suggests his new device as means for increasing the available power output of an engine. In the new silencer there are no baffles—only a cylindrical casing designed to receive the exhaust gases at one end, and a similar design at the discharge end.

Inside the casing is a rotating shaft on which are mounted four fan units (more can be used if necessary). Each fan has four blades set in such a way that the blades of each are in line with the spaces between adjacent blades in the next unit. The bearings supporting the shaft are mounted away from the hot zone.

When exhaust is passed through the casing, the fans rotate at a high speed, but still producing the necessary silencing effect. As a result, according to Hall, there is a lack of material back pressure, because: even though the power of the exhaust does not act directly on the fans, the fans when rotating, create a suction which balances the power absorption.

Plymouth Designs, And Drops, a V-6

In the past few months there have been whispers about a V-6 engine which was to appear in later models of the 1956 Plymouth. However, the lastest word is that it has been dropped —apparently for good.

An official in the engineering department says that Plymouth has been toying with a V-6 for some time, and likes the idea very much. In fact, he claims that it is better than any L-head 6-cylinder engine. But the demand for V-8 engines and high horsepower has made the expensive tooling-up for a V-6 an unsound venture. Ford, for example, makes and sells less than 15 per cent of its total production in 6-cylinder engines. Plymouth feels that the same ratio would hold true for them, too. The automotive gas turbine, just around the corner, also makes a V-6 an uneconomical idea.

Plymouth said that the problem of an unbalanced engine of a V-6 was overcome with a balanced shaft similar to the cam shaft.

High Frequency Transistor

Bell Telephone Labs has reported that a new record has been achieved in the operation of transistors at high frequencies, with their experimental "junction tetrode" transistors generating more than a billion oscillations per second. This was accomplished by the addition of a fourth electrode to the basic junction transistor.

The earlier transistor is a three-layer "sandwich" of germanium sealed in a metal can. The outside layers are of n-type (negative) germanium, and the central layer is of p-type (positive).

This new transistor will allow hundreds of telephone conversations to be carried over a single pair of wires at one time.

COMING EVENTS

NOV. 7-9

Eastern Joint Computer Conference, Hotel Statler, Boston, Mass. Subjects of the Various Sessions are: Computers in Basic Business Applications; Operations Control With An Electronic Computer; Manual Use of Automatic Records; Document Processing; Trends in System Design; Communication & Compatibility Among Electronic Computers in Business and Industrial Use.

NOV. 9, 10

Fuels & Lubricants Meeting of the Society of Automotive Engineers, at the Bellevue-Stratford, Philadelphia, Pa. Subjects: Engine Deposits; Fuel Injection; and Engine Requirements, octane numbers, and gasoline volatility.

NOV. 13-18

Diamond Jubilee Annual Meeting of the ASME at the Congress, Conrad Hilton and Sheraton-Blackstone Hotels in Chicago, Ill. Special features commemorating ASME's 75th anniversary have been planned. More than 300 technical papers at 110 sessions have been scheduled covering a variety of subjects. At the Aviation Div. meeting, there will be a disussion of the heavy press program, past, present, and future. The Aviation meeting will consist of two sessions, both to be held on Nov. 14th.

The American Rocket Society, celebrating its 25th Anniversary, is holding its sessions within the ASME meeting. In addition to the meeting, the "Exposition of Power and Mechanical Engineering" will be held at the Chicago Coliseum. Among the highlights of the exposition will be a series of papers by the Nuclear Engineering Div. of the ASME.

NOV. 14-17

Second International Automation Exposition at the Navy Pier, Chicago, Illinois. Products on display will include all components and equipment necessary to automate any process in an office or plant, from automatic assembly, handling, and data processing equipment, to subminiature relays and switches. Besides the 200 exhibiting manufacturers, there will be two lecture–demonstration clinics, one on Electronic Computers, and one on Conveyor Automation. There will be a 2-day "Senior Officer Conference on Office Automation" sponsored by the Univ. of Chicago. More details on registration and exhibits from: Richard Rimbach Associates, Inc., 845 Ridge Ave., Pittsburgh 12, Pa.

NOV. 16-18

Society of Experimental Stress Analysis, Annual Meeting, Hotel Sheraton, Chicago, Ill. For further information write to Dr. W. M. Murray, Society for Experimental Stress Analysis, P. O. Box 168, Cambridge 39, Massachusetts.

DEC. 5-9

Exposition of Chemical Industries, Silver Anniversary, at the Commercial Museum and Convention Hall, Philadelphia, Pa. Displays will include varieties of machinery and such apparatus as tanks, conveyors and pressure vessels needed in the processing of raw materials and synthetic substances; the chemical treatment of plating and coating, and others. Another group will show the new applications of metals and ceramics, and plastics in the processing field.

DEC. 10-17

Nuclear Congress & Atomic Exposition, Cleveland, Ohio. Under the leadership of the Engineers Joint Council and eight other organizations, there will be about 300 papers covering practically every phase of nuclear development, such as: engineering and scientific phases, insurance, legal, safety, waste disposal, location of atomic power plants, and other problems.

JAN. 9-10, 1956

Reliability and Quality Control, Second National Symposium, Hotel Statler, Washington, D. C. Sponsored by the Institute of Radio Engineers and the American Society for Quality Control. A few subjects: Quality Control & Automation, Reliability of Complex Commercial Equipment; Reliability of Weapons Systems; The Control Chart Applied to Field Failure Data; An Approach to the Study of System Reliability; High Reliability vs. Cost of Equipment & Parts; Advances in Tube Reliability; Controlling Relay Characteristics; and The Problems of Duplicating Operating Environments in Practical Tests.

JAN. 18-20, 1956

1956 Society of Plastics Engineers Conference, Hotel Statler, Cleveland, Ohio. Registration will begin on the 17th with the talks starting Wednesday the 18th and extending through Friday. Subjects to be covered are: Injection Molding Technique and Machinery; Compression and Transfer Technique and Machinery; Extrusion; Calendering and Casting; Reinforcement by fibers, cloth, elastomers; Foams; Physical Properties; Research; Tools & Molds; Defense Applications of Plastics; Automotive and Aircraft Applications; and Rigid Plastics, application and processing.

JAN. 23-26, 1956

7th Plant Maintenance & Engineering Show, Convention Hall, Philadelphia, Pa. At the same time, the Plant Maintenance & Engineering Conference will be presented. About 400 exhibitors are expected at the show, with products shown covering the maintenance in every kind of industry.

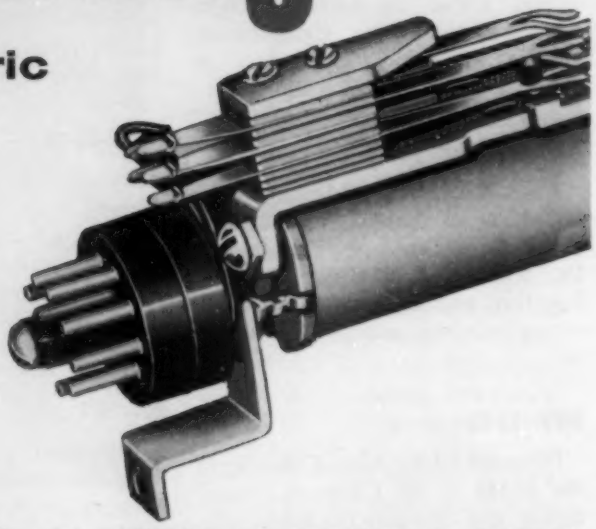
FEB. 7-9

11th Annual SPI Reinforced Plastics Div. Conference, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J. Subject of symposium to be Fatigue and Creep-Rupture of Reinforced plastics. The symposium will bring together speakers with the latest information and pointing up areas needing further investigation. The lack of knowledge of long-time loading effects on plastic containing strong fibrous reinforcements such as glass, has become evident with the increasing application of these materials to aircraft parts, building construction, pipes, and tanks. Authors who wish to submit papers should send abstracts to: C. R. Stock, American Cyanamid Co., Stamford, Connecticut.

you can have the advantages of

plug mounting

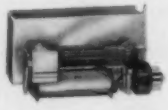
in all these Automatic Electric relays



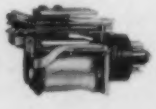
CLASS A:
The "all-purpose" relay for use where first cost is important. Gives long, dependable service. Size: 4⅜" x 2³⁄₁₆" x 1⁷⁄₁₆".

CLASS B:
Made for extremes of long service life and dependability — often exceeding 400 million operations! Size: 4⅜" x 2³⁄₁₆" x 1¼".

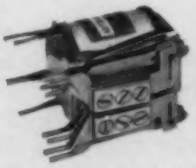
CLASS F:
Low operating power makes this relay especially desirable in a.c. circuits where relays function without specified operate or release time delays. Size: 4⅝" x 1¹⁵⁄₁₆" x 1¼".



CLASS S:
Made for exacting miniature requirements. Used in aircraft where resistance to shock and vibration is needed in a small, light, reliable relay. (For printed circuit applications—see below.) Size: 2⁹⁄₁₆" x 2" x 1¼".



CLASS Z:
Provides maximum timing in a "small-as-possible," low-cost relay. Compact, light, resistant to shock and vibration. Size: 3¼" x 2⅞" x 1¹³⁄₃₂".



"PLUG-IN" RELAY FOR PRINTED CIRCUITS.
Design of coil and spring terminals permits direct insertion into printed circuits with high-conductance connections, easily soldered. Bearing design gives up to 120 million operations without readjustment or relubrication. Size: 1¾" x 1⁵⁄₁₆"-1¾" (depending upon number of contact springs) x 1".

For any application, you can choose an Automatic Electric relay—a top-quality relay in every way—with the additional advantages of *plug mounting:*

Minimized inventory—When you standardize on plug-in relays, you can often interchange the same basic relay in many models of your equipment. Thus, you make substantial savings by reducing your inventory costs, speeding assembly.

Fast, simplified inspection and maintenance—Plug-in relays permit periodic bench inspections with almost no "down time" involved. Entire banks of relays can be removed for testing, and then replaced, in *seconds.*

Simplified replacement—Plug-mounted relays can be replaced quickly and easily at otherwise inaccessible points in your equipment. Even an unskilled service man can replace relays in a matter of seconds without tampering with circuit wiring.

You can select Automatic Electric plug-in relays from five basic types and thousands of individual assemblies.

Send for Relay Circulars 1800—1804—They give complete specifications, dimensional drawings, and helpful information. *Address* Automatic Electric Sales Corporation, 1033 West Van Buren Street, (HAymarket 1-4300) Chicago 7, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES
AUTOMATIC ELECTRIC
ORIGINATORS OF THE AUTOMATIC DIAL TELEPHONE
CHICAGO

Nomographs Relating Hydraulic, Pneumatic and Electrical Energy

A. E. MAINE
DeHavilland Aircraft of Canada, Ltd.

1. PNEUMATIC TO ELECTRICAL ENERGY

The chart in Fig. 1 calculates the air flow required to provide a given amount of electrical or mechanical power. The efficiency scales does not go beyond 50 per cent because most pneumatic devices have efficiencies within this range. For example, usual values for impluse turbines are from 5 to 40 per cent.

The expression upon which the chart is based is

$$W = \frac{2.19F\left(1 - \gamma\frac{K-1}{K}\right)}{\epsilon} \times 100$$

Where

W = power in kilowatts
F = flow in lb per min
γ = pressure ratio
K = specific heat ratio (1.4 for air)
ϵ = efficiency factor

EXAMPLE

Find the air consumption for an output of 120 watts from an impulse turbine generator operating at a feed pressure of 50 psi gage with an over-all efficiency of 20 per cent.

The pressure ratio at sea level is 14.7/(14.7+50) which equals 0.227. A line is drawn from this point on scale *A* to 20 per cent on scale *E* noting the intersection with reference line *C*. Connecting this intersection with 120 watts on scale *B* yields 0.79 lb/min on scale *D*. For larger air flows and powers, the range of the nomogram is simply extended by multiplying the *B* and *D* scales by a common factor.

2. HYDRAULIC TO ELECTRICAL ENERGY

The chart in Fig. 2 will simplify estimating the flows needed to supply a given amount of electrical power at a given pressure. The flow scale is in Imperial gallons. (Multiply by 1.205 to convert to U. S. gallons.)

The equation for the chart is

$$W = \frac{FP\epsilon}{K}$$

Where

W = equivalent power in kilowatts
F = flow in Imperial gallons per hr
P = pressure in lb per sq in.
K = constant = 115
ϵ = efficiency of conversion from hydraulic to mechanical power

EXAMPLE

Estimate the flow required for a hydraulic motor to eventually deliver 80 watts at a supply pressure of 300 psi, a back pressure of 40 psi and an efficiency of 30 per cent.

The pressure drop across the motor is 300 – 40 = 260 psi. This point on scale *E* is connected with 80 watts (0.08 kw) on scale *A*. The intersection on reference line *C* is joined to 30 per cent on scale *D*. On scale *B*, the required flow is 118 gal/hr = 9.07 in.^{3}/sec.

(continued on page 213)

Because VERSA has a Stock Control Valve to fit your exact specifications

. . . You'll Save Money!

40,000 MODELS

From more than 40,000 models, Versa can supply you with a stock valve to fit ANY low or intermediate pressure hydraulic or pneumatic control need.
This vast selection eliminates design delays, costly special tooling, difficult mounting procedures and bulky space wasting attachments.

BASIC TYPES IN ALL SIZES

Four body types, 2-way, 3-way, 4-way and 5-way, with either side ports or manifold ports, form the basic VERSA VALVE line. These types graduate in size: ⅛, ¼, ⅜, ½, ¾, and 1 NPT.

ACTUATION FOR EVERY NEED

Over twenty Versa actuating devices can be used at one or both ends of Versa Valve bodies in a multitude of combinations.

DESIGNED FOR LONGER LIFE

The functional clean straight line design, utilizing balanced pressure action, standard "O" ring packings and full capacity flow passages are built-in guarantees for millions of trouble-free operational cycles. All actuation devices and side ports are clear of the flat base to insure fast installation.

EASY MAINTENANCE

With only common hand tools, any VERSA VALVE can be taken apart in a matter of seconds and serviced without disturbing pressure lines or connections. All interchangeable parts keep down time on VERSA VALVES to a minimum.

FREE CATALOG

The entire line of VERSA VALVES is fully explained in our new comprehensive folder No. 14. For your free copy, write to Dept. E at the address below.

VERSA VALVES

FOR EFFICIENT CONTROL OF AIR, OIL AND WATER

VERSA

VERSA PRODUCTS COMPANY, INCORPORATED
249 SCHOLES STREET BROOKLYN 6, N. Y.

PRODUCT ENGINEERING - REFERENCE BOOK SHEET

Nomographs Relating Hydraulic, Pneumatic and Electrical Energy (continued from page 211)

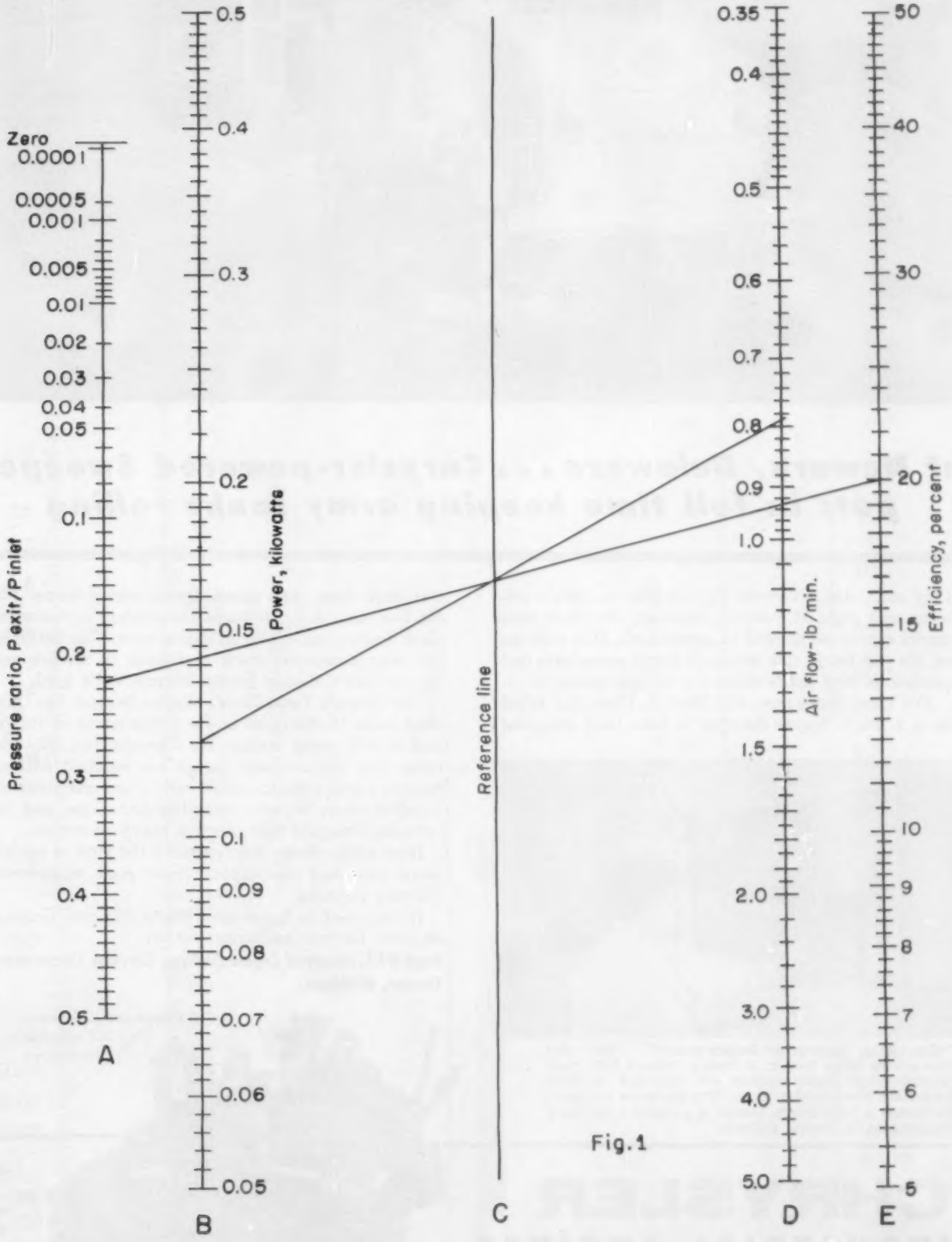


Fig. 1

(continued on page 215)

Cleans Up Clay, Piles Up Records

at Newark, Delaware . . . Chrysler-powered Sweeper puts in full time keeping army tanks rolling

Clay can't stop a General Patton. But at the government tank plant at Newark, Delaware, clay from tank tracks cannot be allowed to accumulate. If it piles up on the test track, clay and mud might complicate test operations. And that's where the sweeper comes in.

For three years now, the Newark Plant has relied upon a single Wayne Sweeper to keep their mile-long test track clean, their paved streets clear of debris. The job is a big one . . . it keeps the sweeper in operation eight hours a day, five or six days a week. Clay flattened out onto a concrete track is difficult to remove and the sweeper's double gutter brooms work hard.

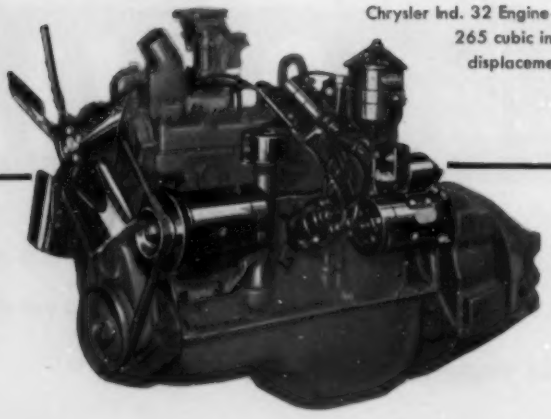
The Newark Tank Plant's Wayne Sweeper has travelled some 46,000 miles in the performance of its job and is still going strong. Its Chrysler Ind. 32—265 cubic inch displacement engine has required nothing beyond routine maintenance care. Plant maintenance superintendent reports operating costs—gas and oil consumption—are light despite heavy operation.

Here again we see demonstrated the kind of service users can—*and do*—expect from good equipment, Chrysler-powered.

If you want to know more about Chrysler Engines as power for your equipment, write:

Dept. 611, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.

"One-Man Sanitation Department". . . that's what they call the Wayne Sweeper at Newark, Delaware Tank Plant. Chrysler Ind. 32 Engine equipped with heavy-duty four-speed transmission powers brushes, hopper-filling mechanism, and travels the sweeper at traffic speeds. Sweeper is a product of the Wayne Manufacturing Co., Pomona, California.



Chrysler Ind. 32 Engine—
265 cubic inch
displacement

CHRYSLER
INDUSTRIAL ENGINES
INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

HORSEPOWER
WITH A
PEDIGREE

PRODUCT ENGINEERING - REFERENCE BOOK SHEET

Nomographs Relating Hydraulic, Pneumatic and Electrical Energy (continued from page 213)

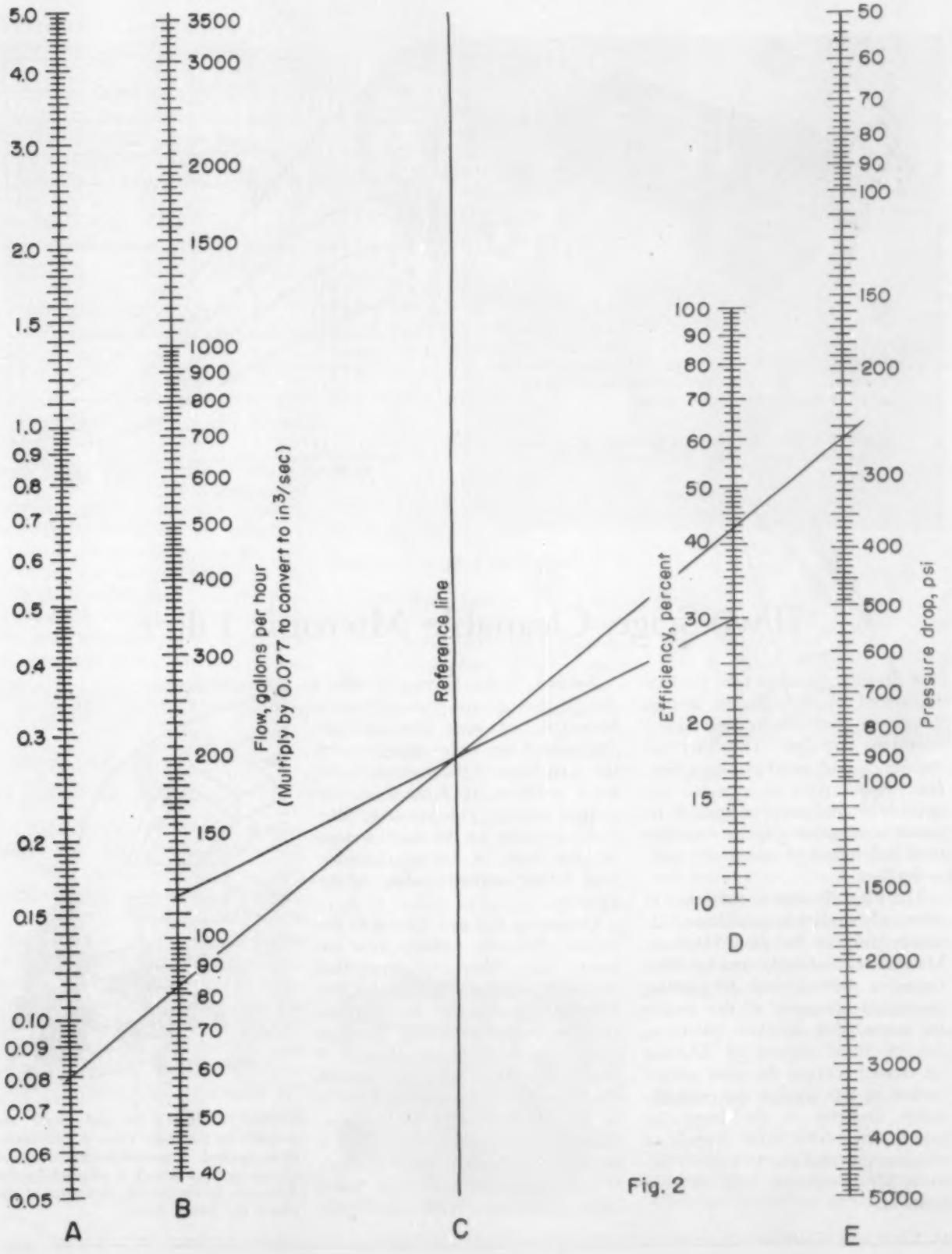
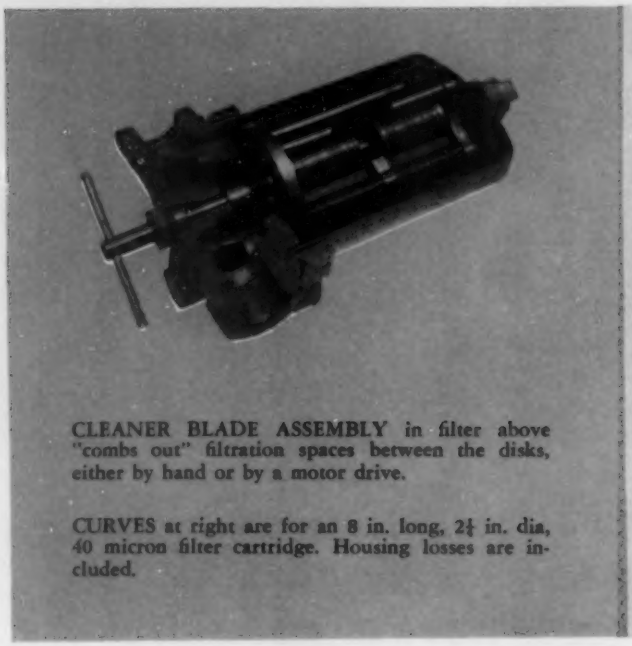
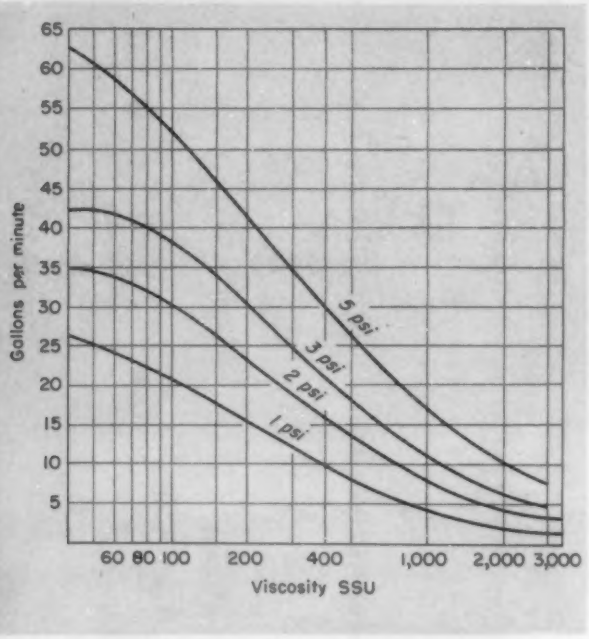


Fig. 2



CLEANER BLADE ASSEMBLY in filter above "combs out" filtration spaces between the disks, either by hand or by a motor drive.

CURVES at right are for an 8 in. long, 2¼ in. dia, 40 micron filter cartridge. Housing losses are included.



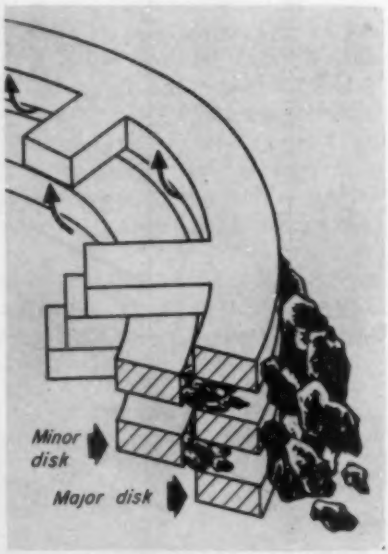
Two-Stage, Cleanable Micronic Filter

A cleanable micronic filter has been announced which minimizes pressure drops and eliminates use of replacement-type cartridges. This filter uses the principal of metal edge-type filtration. Applications are expected particularly in fluid power equipment, internal combustion engines, machine tools and industrial machinery, processing lines.

The filter element is composed of alternately stacked large and small diamater disks of the same thickness. Material of construction can be either carbon or stainless steel. By grinding the outside diameter of the smaller (or minor) disk to close tolerances, one of three degrees of filtration are created between the outer ground surface of this smaller disk and the inside diameter of the larger (or major) disk. The three degrees of filtration provided are: 40 microns (actually 37) 75 microns (0.003 in.) and 0.005 in.

Because of the filtering element's design, a second (or primary) filter is formed in the space (the 0.012 in. thickness of the minor disk) between the outer edges of the major disk. All larger particles are stopped by this primary barrier. This two-stage filter design accounts for the ability to handle dirt loads of varying characteristics without undue "loading" of the cartridge.

Comparing this new filter with the normal replaceable cartridge type micronic filter makes it apparent that size is the most readily apparent difference. For example, the manufacturer states that an average cartridge type filter able to handle 30 gpm of clean 200 SSU oil at 2 psi pressure drop would be approximately 30 x 10 in. dia. A single filter of the new, cleanable type would measure 15 x 6 in. wide (or about six times smaller). It will handle the same flow under similar conditions. With only slightly



PARTICLES 0.012 in. and larger are stopped by the outer edges of the major disk. Second stage edge-type filtration (down to 37 micron) is affected by the difference in the outside diameters of the major and minor disks.

higher pressure drop, the new filter is reported to handle 75 per cent more flow.

Particles larger than 0.012 in. are stopped by the primary filter formed by the major disks; those larger than rated size are stopped by the minor disks. Each cleaner blade in the stack fits into the 0.012 in. slot between major disks and bears against the outside diameter of the minor disk. All dirt is "plowed" or "combed" out when the disks are rotated against the cleaner blades.

This rotation may be operated by hand or motor drive. If by hand, it is done as often as experience proves necessary. If by motor, it can be continuous or according to any desired cycle.

While replacement cartridges are done away with in this design, the new filter is said to eliminate or reduce cartridge replacement on secondary micronic filters, where very fine tolerances or a heavy dirt load are involved. Standard models of the filter are available for built-in designs, which do away with external piping. Cuno Engineering Corp., Meriden, Conn.

For more information—
Circle 1, inside back cover

Motor-Driven Time Delay Relay

A synchronous, motor-driven time delay relay has two pointers to indicate time setting and progress. Setting mechanism provides quick, easy adjustability over full dial range, even while timer is operating. A sealing-in contact permits timer operation from either momentary or sustained closure.

Two single-pole, double-throw and one single-pole, single-throw heavy duty open-blade contacts provide positive quick-make, quick-break operation. Contacts, rated 15 amp at 125 v, ac, are of silver cadmium oxide. Accuracy of Type 412 is within ½ of 1 per cent of full scale. Repeat accuracy is within ¼ of 1 per cent of full scale on timers with 30 sec and

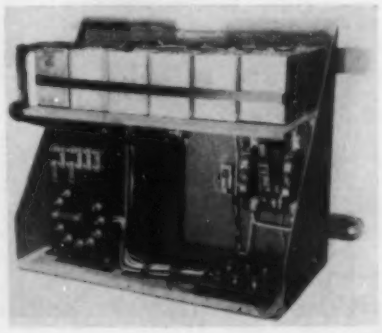
longer ranges; ½ of 1 per cent on shorter range units. The timer is offered in 14 time ranges from 6 sec through 24 hr, in 115 and 220 v, 25, 50 and 60 cps. R. W. Cramer Co., Inc., Centerbrook, Conn.

For more information—
Circle 2, inside back cover

Phase Converter Provides Balanced Single Phase Currents

This device permits the use of single or double squirrel cage, variable speed, and two-speed, three-phase motors on a single-phase, 240-v line. Such static phase converters are not new, but the manufacturer claims that whereas most converters on the market draw dangerously excessive currents in three-phase motors, this design will eliminate this problem.

This converter causes a voltage rise due to one of the circuit elements built into the unit. This voltage rise offsets the voltage drop due to the inrush at starting. This tends to reduce light flicker. The new converting device is designed in accordance with horsepower ratings of different sizes and types of motors. However, it can be used in conjunction with several motors if at least two thirds of the connected load is started, operated and stopped simultaneously, and ratings are not exceeded. The unit can be adjusted for lower capacity motors.



The phase converter is built for 150, 200 per cent and special high torque, for 1 to 30 hp motors are available. System Analyzer Corp., 700 W. State St., Nokomis, Ill.

For more information—
Circle 3, inside back cover

Miniature Screws

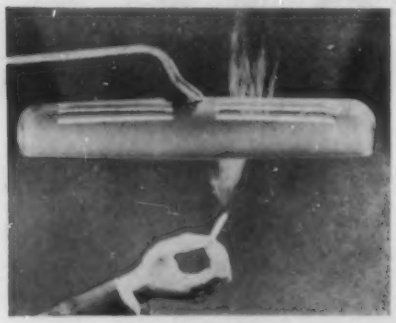
A line of miniature socket cap and set screws, in diameters No. 0 through No. 3 is now being produced. Lengths run from ⅛ to ½ in. Cap and set screws are manufactured in both coarse and fine series, unified threads, except No. 0 and No. 1 diameters, which are standard in fine series only. Allen Mfg. Co., Hartford 2, Conn.

For more information—
Circle 4, inside back cover

Drafting Board Lamp

A louvered shade on this lamp is reported to provide an upward glow of light that cuts down eyestrain by eliminating shadows and minimizing

CONTINUED ON PAGE 218



contrasts. Six separate louvers are built into the top of the all-metal shade. A universal adjustment arrangement employs the gravity principle. Adjustments are virtually unlimited and frictionless.

This new drafting board fixture extends from 12 in., min, to 37 in., max. A total of eight models in both fluorescent and incandescent types are included. Furies Lamp Div., General Lamps Mfg. Corp., Elwood, Ind.

For more information—
Circle 5, inside back cover

Vinyl-Coated Embossed Steel

Embossed steel is now available with a fused vinyl coating, in any color. Patterns are deeply embossed by this manufacturer's method and remain unaffected by any of the standard fabrication techniques, including deep drawing. Available in coil or sheet form up to 48 in. wide, the embossing process is said to increase strength and stiffness up to 30 per cent.

The vinyl coating, fused to the metal and hardened to a tough surface under about 100 tons pressure, is unaffected by forming, bending, punching or deepdrawing. Sun Steel Co., 1702 W. 74 Pl., Chicago 36, Ill.

For more information—
Circle 6, inside back cover

Filter for Hydraulic Systems

A filter for the hydraulic systems of large, high-speed machine tools is said to be capable of filtering micronic size particles at operating pressures of 1000 psi. The new filter handles flow rates of up to 75 gpm. Made of resin-impregnated paper, the micronic filter element is easily replaceable by removing the snap ring holding the case cover in place.

The case itself is of steel construction and contain an O-ring seal in its head. At either end of the new hydraulic system filter's case are 1½ in. connections. Purolator Products, Inc., Rahway, N. J.

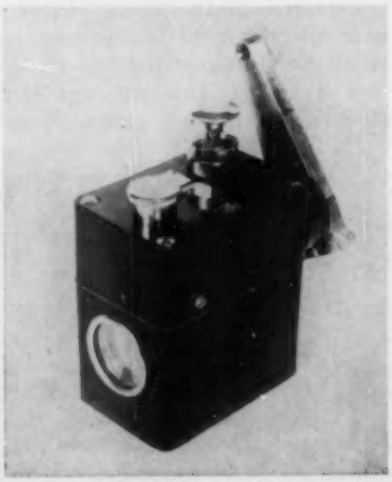
For more information—
Circle 7, inside back cover

MECHANICAL COMPONENTS

Lubricator For Small Machines

An automatic lubricator with a newly designed, close-fitting ratchet drive provides centralized lubrication on small machines where a minimum of installation space is available, according to the manufacturer. The cyclic type lubricator will feed controlled amounts of oil to as many as 25 bearing points on a machine. Measuring 2 x 3 x 4¼ in; the unit is designed to lubricate small complex mechanisms such as are found on circular knitting machines, bench top presses, tabulating machines and testing machinery.

The new lubricator is powered by the machinery it lubricates. The adjustable ratchet is attached to a shaft from a convenient drive on the machine. Drive is transmitted through a series of reduction gears to a piston-type pump. The pump discharges oil at 30 psi into a distribution system of ⅛ in. tubing. Oil is transmitted through branch lines to meter-units at each bearing point, where oil is filtered and measured in exact amounts.



The reservoir in the bottom of the unit has an 80 cc capacity, and the pump delivers 0.4 cc of oil per discharge. The lubricator is available with any of four different sets of hobbed steel reduction gears, providing reduction ratios ranging from 100:1 to 2.25 million:1. Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

For more information—
Circle 8, inside back cover

Heat-Expanding Gasket

When heat is applied (as when passed through a paint bake oven), the compound this gasket is made of expands to fill every contour of its confining area up to precontrolled limits, from 50 to 200 per cent. After expansion and vulcanization, the gasket retains its shape. Nor is there any loss of adhesion or flexibility, after the curing cycle, at temperatures as low as 0 F. Presstite Engineering Co., 3796 Chouteau Ave., St. Louis 10, Mo.

For more information—
Circle 9, inside back cover

Mastic Washers and Gaskets

This mastic-type washer and gasket cold-flows into any annular space or void when pressure is applied. The amount of flow is controlled by the amount of material used. This factor is predetermined by matching the

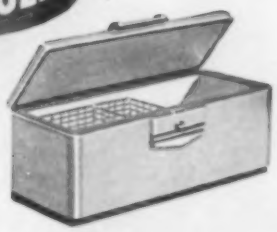
CONTINUED ON PAGE 220

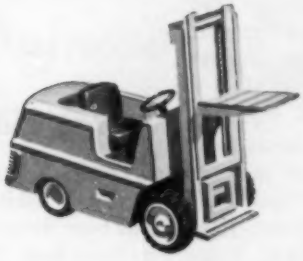
MAKE IT WEIGH LESS

N-A-X

HIGH-TENSILE STEEL

MAKE IT LAST LONGER





You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

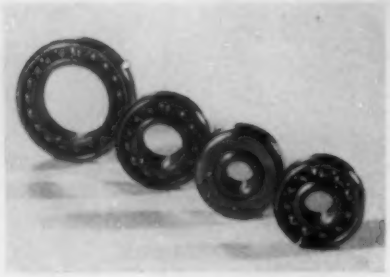
NATIONAL STEEL CORPORATION

right washer size and shape to the particular job.

Adhesion to metal, glass and plastic is claimed, and the mastic will not get brittle or shrink with age. Useful from −40 F to 375 F.

These new washers and gaskets can be had in stock sizes and shapes, or in made-to-order sizes and shapes in quantities of 20,000 or more. Presstite Engineering Co., 3796 Chouteau Ave., St. Louis 10, Mo.

For more information—
Circle 10, inside back cover



Ball Bearings Up to ½ in. Shaft Dia

Adaptable to shaft sizes up to ½ in. dia, these bearings incorporate a design principle which is said to cut installation time up to 78 per cent. Available in both standard and sealed models, the new bearings have precision-ground balls and case-hardened races to withstand heavy radial loads. Intended for general purpose, low rpm applications. Freeway Washer & Stamping Co., 4911 Grant Ave., Cleveland 5, Ohio

For more information—
Circle 11, inside back cover

Gear Box with Ratios From 4:1 to 12,000:1

With a range in ratio of 4:1 to 12,000:1, these gear assemblies provide torque from 150 in-oz. to 200 in-oz. Applications include servo mechanisms, computers, small actuators and electronic components.

Available in two series, 145 and 167, the gear boxes are designed so they can be mounted directly to small electric motors. If desired, they can also be supplied with an input shaft. Weight ranges from 2½ to 5 oz. The Series 145 is 1.45 x 1.5 in. long. Southwestern Industries, 5880 Centinela Ave., Los Angeles 45, Calif.

For more information—
Circle 12, inside back cover

Sub-Miniature Speed Reducer

This device measures 0.937 in. dia and adds just ⅝ in. length to size 10 motors in its 26.4:1 reduction ratio. The unit can be furnished in all practical ratios. This speed reducer contains, in addition to its gear clusters, an adjustable slip clutch. Backlash is less than 30 min, and its weight is 1¼ oz. The housing is stainless steel. Gear clusters and pinions are also stainless steel, and ABEC Class 5 ball bearings are used throughout. Bowmar Instrument Corp., 2432 Pennsylvania St., Fort Wayne, Ind.

For more information—
Circle 13, inside back cover

Variable Speed Pulley

A ¼-hp variable speed pulley is now available for limited space applications. It is so designed that it can be mounted with the belt take-off close to the motor and/or reversed, in which case the belt take-off is in an overhung position away from the motor. The new pulley delivers speed ratios up to 2:1. An A-section belt is used. Maximum bore is ⅝ in. with keyway. Overall dimensions are 3⅛ x 3 in. dia. Weight is 26 oz. Lovejoy Flexible Coupling Co., 4873 W. Lake St., Chicago 44, Ill.

For more information—
Circle 14, inside back cover

Hammer-Type Four Lug Nut Union

This union is being made in 2 to 4 in. sizes, inclusive. Both lug and hexagonal shaped nuts are combined with regular or double-start threads, for fast make or break with either a hammer or wrench. The new unions are hot-forged from solid steel bars, conforming to ASTM A-105, grade 2. Catawissa Valve & Fittings Co., Catawissa, Pa.

For more information—
Circle 15, inside back cover

Worms and Gears

Precision ground worms are immediately available in single, double and four threads. All are right hand, in three basic shaft sizes: ⅛, ⅜ and ¼ in. dia. Material used in the worms is Type 303 stainless steel.

Worm gears are also available from stock designed to run with the above worms in numbers of teeth, varying from 60 to 120. Also in three basic shaft sizes: ⅛, ⅜ and ¼ in. dia. Material used in the worm gears is gear bronze. Pic Design Corp., 160 Atlantic Ave., Lynbrook, N. Y.

For more information—
Circle 16, inside back cover

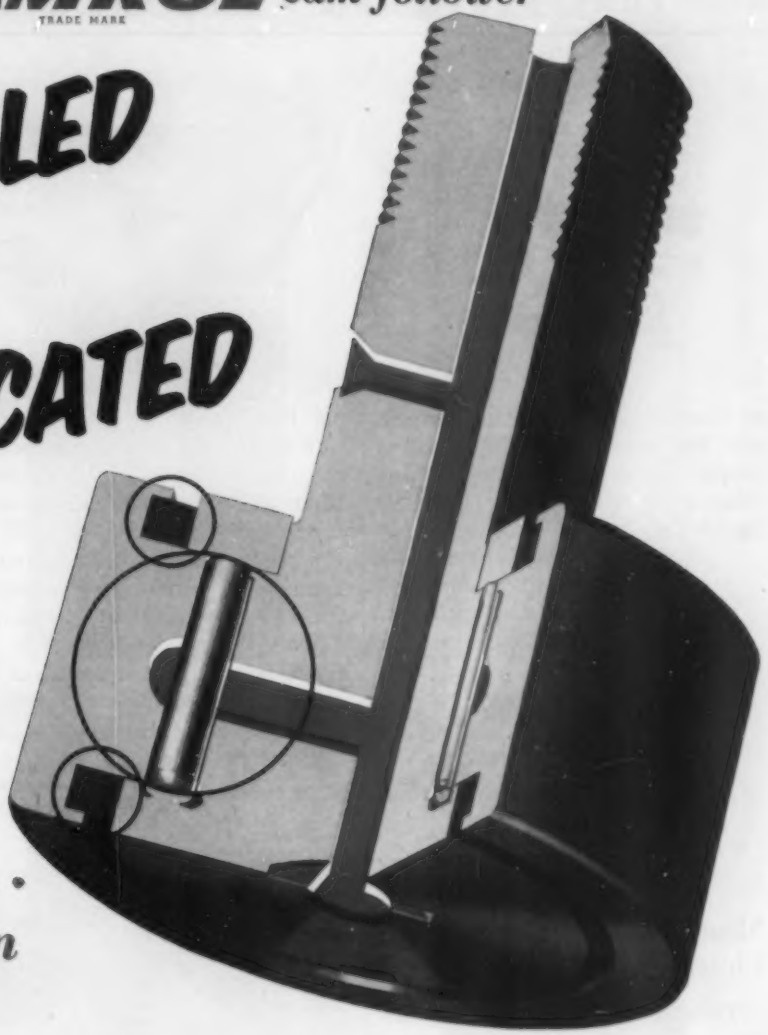
Oil-Actuated, Multiple-Plate Clutches

Both models of this clutch are readily adaptable to remote or push-button control without mechanical linkage. Since the floating or pressure plate forms the ram of the cylinder, the ram travel increases automatically as the plate stack wears. This is said

CONTINUED ON PAGE 222

the NEW McGILL® **CAMROL** TRADE MARK *cam follower*

NOW SEALED and PRELUBRICATED



to eliminate contamination . . . save re-lubrication

McGILL®

SCF series

CAMROL TRADE MARK

bearings

Write for your copy today

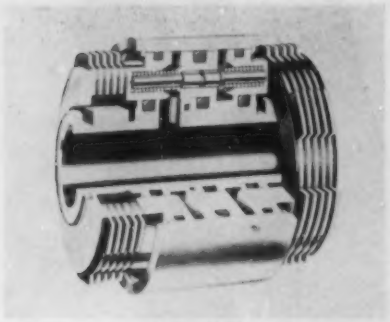
In one simple assembly, the Sealed CAMROL cam follower bearing gives you three big advantages: 1. capacity to withstand the shock and load of cam action, 2. sealing against contamination that would impair the life of an unprotected bearing, 3. prelubrication that saves frequent relubrication so often undesirable in cam action application. Specially treated seals are built in at stud and flange ends, and a black oxide finish offers outside corrosion resistance. A channeled reservoir in the outer raceway bore helps store reserve lubrication sufficient in many cases for lifetime service. The new SCF series bearings do not add to the size or weight of standard CAMROL cam followers and are dimensionally interchangeable with them. Ask your McGill representative to show you this newest McGill contribution to the superior performance of your cam actioned machinery, or write to our engineering department for recommendations. Send for Bulletin SCF-55 for more detailed information.

Insure performance with McGILL®...

50th Anniversary

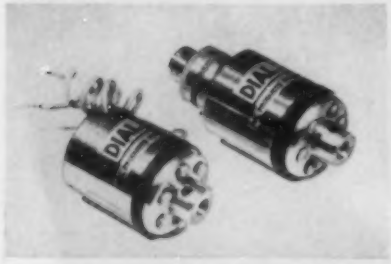
MULTIROL®—GUIDEROL®—CAMROL full type roller bearings

McGILL MANUFACTURING COMPANY, 201 N. Lafayette Street, Valparaiso, Indiana



to eliminate adjustments to compensate for plate wear, and constant torque transmitting ability is provided in the new clutch. Twin Disc Clutch Co., Racine, Wis.

For more information—
Circle 17, inside back cover



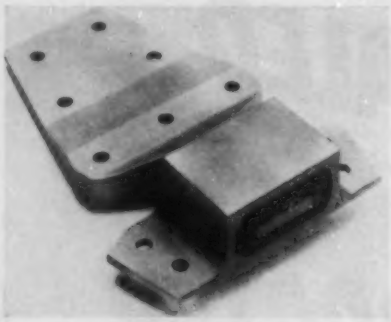
Miniature Clutches and Brakes

These units weigh 2½ oz, measure less than 1 in. dia and consume about 2 w of power. They deliver 30 in-oz of torque. They can be used at speeds up to 4000 rpm, and their response time ranges from 10 to 15 millisec, depending upon the power input and load characteristics. Dial Products Co., 9 Ave. E, Bayonne, N. J.

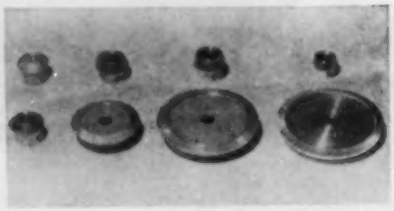
For more information—
Circle 18, inside back cover

Aluminum-Rubber Shock Mountings

Lightweight aluminum and rubber bracket and shock mounting assemblies that were developed to support after-body engine sections in aircraft are said to be capable of operating under conditions of high frequency vibrations. The mount is designed to withstand applied loads in shear. These loads are taken out by 11¼ in. dia bolts, with the vibration completely absorbed by a Neoprene rubber core 1⅞ x 1⅝ x 1¼ in. deep, bonded to the aluminum. Operating temperatures range from −65 to 175 F. Adaptations of the mount are available for other piston-powered aircraft engines and the vibration-absorption principle is expected to find application in general industrial and commercial equipment. Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif.



For more information—
Circle 19, inside back cover



Miter and Bevel Gears

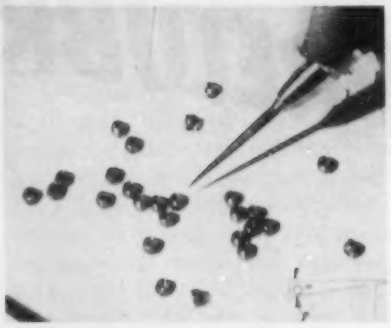
Precision pin hub type miter and bevel gears are available from stock in type 303 stainless steel, clear passivated, or 24ST aluminum, chromic acid anodized (before cutting). Cut to AGMA Precision 1 tolerances. These gears are stocked in 48, 64, and 72 pitches with 20-deg pressure angle and in three basic shaft sizes, ⅛, ⅜ and ¼ in. Pic Design Corp., 160 Atlantic Ave., Lynbrook, N. Y.

For more information—
Circle 20, inside back cover

All-Vinyl Hand Grips

An all-vinyl plastic hand grip has been developed with inside coring that is said to give a shock absorber action while at the same time assuring a snug fit to the bar. The slightest exertion of pressure tends to increase the gripping action. The Model E grip is made for ⅞, ¾ and ⅝ in. bars, and is available in standard colors of red, green, yellow, maroon, black, blue, white and ivory. Ohio Rubber Co., Willoughby, Ohio.

For more information—
Circle 21, inside back cover



Self-Locking Miniature Nuts

A line of miniature fasteners for instrument and electronic applications range in size from 0-80 up to 4-48. The 0-80 micro nut, smallest in the line, measures less than ⅛ in. across its largest dimension.

The nut is a one-piece, all-metal fastener that functions as a stop nut as well as a locknut. Standard Pressed Steel Co., Jenkintown, Pa.

For more information—
Circle 22, inside back cover

Quarter-Turn Fastener

Designed to hold plates of metal, plastic or plywood pressuretight, these fasteners withstand shock, vibration and extreme stress. A quick quarter turn clockwise locks them; reverse action unlocks. They cannot be partially or incorrectly locked, nor can they be over-torqued.

Three fastener types are standard. All head styles are provided—oval, flush, knurled, ring, notched, wing, or to specifications. South Chester Corp., 200 Industrial Highway, Lester, Pa.

For more information—
Circle 23, inside back cover

CONTINUED ON PAGE 224

Ostuco Welded Tubing

. . . Specified by men with responsibility

OSTUCO Welded Tubing **offers design engineers unlimited latitude to create a variety of original but practical product designs.**

Sales Managers can meet **. . . and *beat* the competition with products incorporating OSTUCO Welded Tubing.**

Cost Control is easier **with OSTUCO Welded Tubing. Low initial cost and less time-consuming processing mean *important* savings.**

Extra strength, **less weight, and uniformity of OSTUCO tube walls insures top quality finished products time after time. No rejects here.**

Production runs smoother . . . faster **with OSTUCO Welded Tubing components. Assembly time is reduced, expensive operations eliminated. Production schedules are on *time*.**

OSTUCO's single-source **service design (manufacturing and fabricating under one roof) means error-free handling of every order—large or small. Purchasing can relax . . . less follow-up necessary with OSTUCO.**

OSTUCO SHELBY, OHIO **OSTUCO TUBING**

SEAMLESS AND ELECTRIC WELDED STEEL TUBING
—Fabricating and Forging

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • ***SHELBY, OHIO***
Birthplace of the Seamless Steel Tube Industry in America

SALES OFFICES: *BIRMINGHAM • CHARLOTTE • CHICAGO (Oak Park) CLEVELAND • DAYTON • DENVER • DETROIT (Ferndale) HOUSTON • LOS ANGELES (Beverly Hills) • MOLINE NEW YORK • NORTH KANSAS CITY • PHILADELPHIA PITTSBURGH • RICHMOND • ROCHESTER • ST. LOUIS ST. PAUL • SALT LAKE CITY • SEATTLE • TULSA • WICHITA*

CANADA, *RAILWAY & POWER ENGR. CORP., LTD.*

EXPORT: *COPPERWELD STEEL INTERNATIONAL COMPANY 117 Liberty Street, New York 6, New York*

ELECTRIC POWER, CONTROL

For Overvoltage Protection Systems

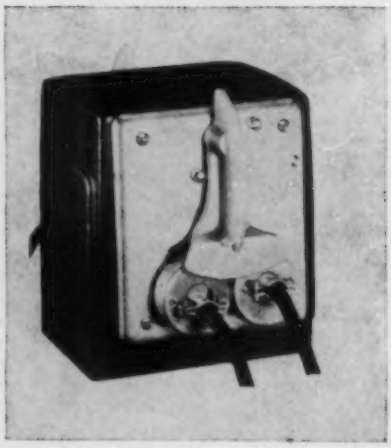
While designed primarily for a-c control panels, this relay can be supplied separately for incorporation into any aircraft a-c electric system or panel. The physical construction of the new relay includes: a hollow metal cylinder used for the cathode. A wire anode is contained inside this cylinder. Two arched metal contact straps are mechanically secured to the cathode, but are electrically isolated. A contact ring is attached to one strap for contacting the other strap when operation is required. The relay is normally used in conjunction with a slave relay, a transformer and two resistors for obtaining the desired voltage levels and time delay characteristics.

A typical operation cycle for the relay begins when a generator overvoltage is sensed and amplified by a transformer. This signal fires the relay. The current flow between anode and cathode acts to heat the cathode. The temperature rise of the cathode is predetermined by design to insure a desirable time delay before circuit completion (it is thus possible to prevent nuisance tripping during normal system switching). As the cathode expands, it stretches the arched straps until both are in contact with the contact ring. This action completes the circuit and trips the slave relay in the generator excitation field circuit. The generator then de-energizes until the overvoltage relay is reset.

The new "glow switch" overvoltage relay is sensitive to the peak voltage and can be used at any a-c supply frequency where the ratio of peak to rms is greater than 1.3:1. The relay contacts are rated at 0.5 amp and 28 v. The time voltage characteristic of the relay is said to be repeatable within 10 per cent of the original time after an elapsed time of 10 sec following operation.

The relay measures 2.38 × 0.383 in. and weighs 0.177. Jack & Heintz, Inc., 17600 Broadway, Cleveland 1, Ohio.

For more information—
Circle 24, inside back cover

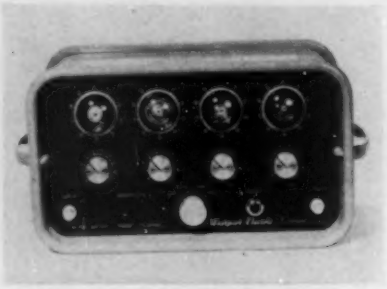


Lock-Type Electrical Receptacles

Designed to eliminate dangers of fire and explosions caused by sparking in hazardous areas, extension cord sets are locked into this device's sockets and cannot be removed or inserted until the trip lever is actuated, which de-energizes each socket. This is said to eliminate all possibility of arcing due to accidental removal of cords.

Heavy duty mercury-to-mercury sealed contactors automatically operate as a circuit breaker. All units made are designed for use with standard flush type receptacles and standard condulet housings for service up to 440 v. Industrial Automation Corp., 2415 W. Montrose Ave., Chicago, Ill.

For more information—
Circle 25, inside back cover



Preset Electronic Counter

Any number from 1 to 9999 may be set by rotating each of the four decade selector switches to the appropriate number. The WE-310 will count until this total has occurred; then, coincident with the last input pulse, the unit provides an output pulse. In the manual position, the instrument counts to the preset number and then opens or closes a pair of relay contacts which hold until the unit is manually reset. Dimensions: 6 x 6 x 11 in. Weight is 12 lb. Westport Electric, 149 Lomita St., El Segundo, Calif.

For more information—
Circle 26, inside back cover

Batch Counters

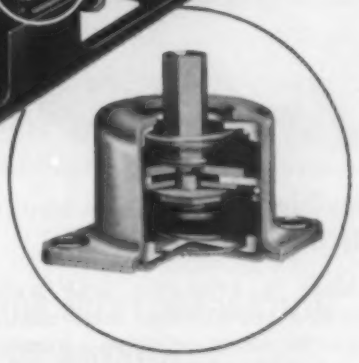
The DS-700 series units are direct-reading totalizing electronic counters especially designed for such applications as industrial batch counting, measuring characteristics of jet engines, turbines, electric motors, counting total revolutions of high speed shafts. These counters, when used with an accessory transducer, will count at speeds far in excess of strictly mechanical counters.

Available in four models, the counters will operate with absolute accuracy from 0 to 100,000 counts per second, depending on the number of decades.

CONTINUED ON PAGE 226

JACK & HEINTZ
MODEL 50127-000
CONTROL PANEL

PHOTOS COURTESY OF
CONVAIR AND JACK & HEINTZ.



ALL-ANGL Barry Mounts give sure protection

Jack & Heintz proved this in testing mounts to protect their Hi-Phase voltage regulators and control panels for Convair's supersonic F-102A interceptor.

No other miniature isolator tested could meet Procedure I of MIL-E-5272A. ALL-ANGL Barry mounts exceeded life-test requirements.

And the ALL-ANGL works in any position— to give sure protection for vital controls through every twist, turn, and dive in the aircraft's most violent maneuvers.

Write for Data Sheet J-11. And for your airborne requirements to meet standard MIL specifications, ask about All-Metl, Air-damped, and special Barry mounts.

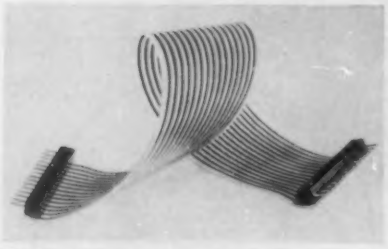
Here's the mount that meets the new needs of today's jet aircraft and missiles — where equipment must have greater protection against shock and high-frequency vibrations—and where MIL-standard mounts prove inadequate.

BARRY CONTROLS incorporated **730 Pleasant St. Watertown 72, Mass.**

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

A mechanical register extends the maximum count capacity to 9,999,-999,999 on Model DS-740, the four-decade unit. Count capacity of the smaller DS-710 is 9,999,999. Relay contact closure and negative output pulse of approximately 100 v is provided each time the electronic decade section reaches maximum count. Relay contacts are rated at 5 amp, 115 v, 60 cps. Net weight ranges from 8½ to 13½ lb. Computer-Measurements Corp., 5457 Cleon Ave., N. Hollywood, Calif.

For more information—
Circle 27, inside back cover



Flexible Printed Circuit Cables

Made by laminating Kel-F with copper in thin sheets, these multi-conductor cables or wiring harnesses are adaptable to many types of connectors or terminations and are easily secured by clamps, rivets or cement. Additional conducting and insulating layers can be added to the basic cable to provide a greater number of separate conductors. As many as three conducting layers are possible, depending on the flexibility required. Each layer is made slightly shorter than the layer below to expose all the conductor ends for solder connection. Stacked circuits have been built up to five layers and may go higher depending on the application. Sanders Associates, Inc., Nashua, N. H.

For more information—
Circle 28, inside back cover

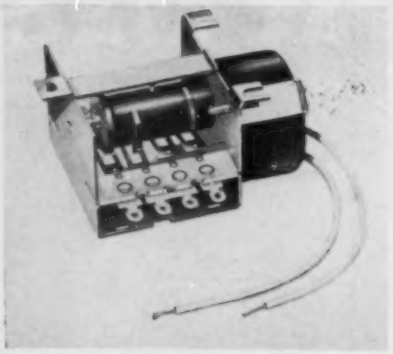
Elapsed Time Indicator

This running time meter is a direct-reading counter, with a synchronous motor drive, in a 1½ in. dia case. The unit is 2¾ in. in length, weighs less than 6 oz, and uses approximately 2 w of power. Two models are available, one indicating hours in 1/10 hr steps to 9999.9; the other, minutes in 1/10 min graduations to 9999.9 (166.6 hr). The units operate on 115 v, 400 cps current, are glass-to-metal hermetically sealed, and can be mounted either behind or in front of the mounting panel. Electrical connections in this new elapsed time indicator are from the end through solder-type terminals. Haydon Mfg. Co., 245 E. Elm St., Torrington, Conn.

For more information—
Circle 29, inside back cover

Interval Timing Switch

This device controls four different circuits to generate four different operations during an 8-sec cycle. As applied to an automatic vending machine, for example, it can control a typical sequence of dropping a cup into place, opening a filling valve, closing the valve and releasing a latch, and totalizing sales.



The basic switch action can be supplied in varied lengths of total cycle, and with facilities for controlling varied numbers of circuits. It is applicable to many types of automatic sequence controls for machine tools and other relatively short-interval uses.

The switch operates from standard 110 v, 60 cps power lines. It is UL-approved. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.

For more information—
Circle 30, inside back cover

Aluminum-Housed Footswitch

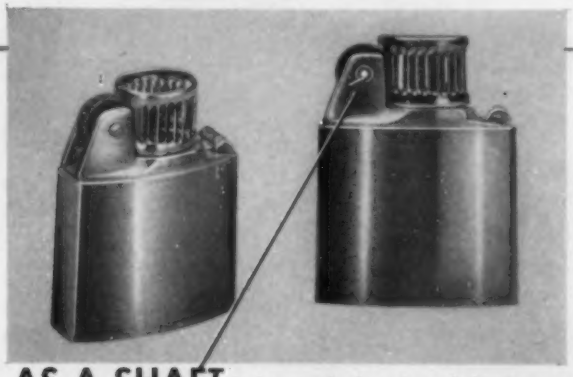
This footswitch was designed for normal and heavy duty switching. It is suggested for operation of industrial machinery, business machines, magnetic switches, stapling machines, photographic equipment.

The main feature of this footswitch is that it can be mounted on the floor or on machinery. It is also available without mounts. The con-

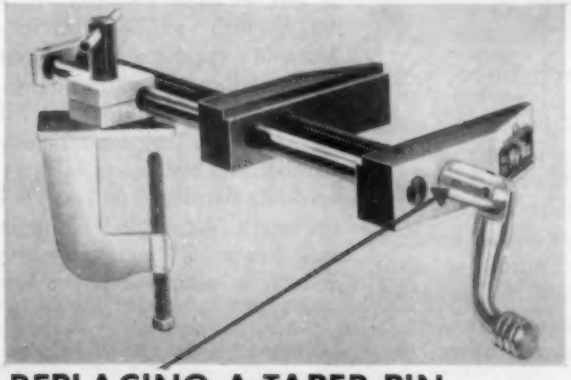
CONTINUED ON PAGE 228

Three typical Rollpin cost reductions

AS A RIVET Rollpin cuts material and assembly costs 25% on Reynolds Gas Regulator Co.'s toggle lever assembly.



AS A SHAFT before and after shot of this Ronson lighter shows how Rollpin made savings of 1½¢ per unit in assembly of spark wheel.



REPLACING A TAPER PIN Rollpin saves 24¢ labor cost on each of American Machine and Foundry's MITY-7-VISES. Eliminates tool cost caused by breakage of small taper reamers.

ESNA® TRADE MARK

ROLLPIN TRADEMARK

Where can you use this simple fastener?

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your production and maintenance costs as it does in every class of industry. Rollpin is a slotted tubular steel pin with chamfered ends that drives easily into standard holes, compressing as driven. Its spring action locks it in place—withstanding impact loading, stress reversals and severe vibration. No threading, peening or precision drilling needed. Rollpin is readily removable and can be re-used in the same hole.

ELASTIC STOP NUT CORPORATION OF AMERICA

MAIL COUPON FOR DESIGN INFORMATION

Elastic Stop Nut Corporation of America
Dept. R38-112, 2330 Vauxhall Road, Union, N. J.

Please send the following fastener information:

☐ Rollpin samples
☐ Rollpin bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

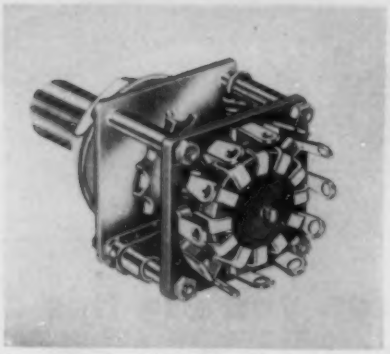
Name_____ Title_____

Firm_____

Street_____ Zone____ State_____

tact rating can be made for 1, 6, and 15 amp, standard. The overall size is 3¾x3x1⅛ in high. It is available with or without the cord and series plug. It is also available in a variety of wiring plans. Vemaline Products Co., P. O. Box 222, Hawthorne, N. J.

For more information—
Circle 31, inside back cover



Miniature, Rotary, 12-Position Switch

This switch is designed for use in applications requiring up to 3 amp at 115 v, ac. Up to six decks can be ganged for operation with a single knob, allowing multi-circuit control in limited space. The unit is ¾ in. square, and weights ½ oz. Switching action can be shorting (make before break) or non-shorting (break before make), with continuous rotation or movement limited from 2 to 11 positions.

Contact terminals are of silver-magnesium-nickel alloy; rotor contacts are spring-tempered silver alloy; and the detent mechanism is made of stainless steel. R-F Electronics, Inc., Weymouth 88, Mass.

For more information—
Circle 32, inside back cover

Toggle Switch Manual Starters

Toggle switch-operated a-c starters for manual, across-the-line starting of small single-phase a-c motors are available in single or double-pole types for a maximum of 220 v, 25 to 60 cps. Bi-metallic thermal overload protection is provided with in-

terchangeable heaters covering the entire range of the starters. Heaters can be readily interchanged from the front without removing the starter or wiring connections. Clark Controller Co., Cleveland 10, Ohio.

For more information—
Circle 33, inside back cover

Centrifugal Switches

This centrifugal switch is a speed regulation unit, separately housed, and furnished in three types: 1) For continuous, automatic speed regulation over a narrow speed band; 2) as a governor control of dual, predetermined minimum–maximum speeds over a greater speed band; 3) to govern a single high speed, or a single low speed.

These controls can handle up to three independent governors for control of multiple or inter-related circuits. They can be located almost anyplace, vertically or horizontally, to detect or control speed on practically any type of device or equipment utilizing rotary motion. It detects rotational speed alone, independently of voltage or load.

The switch is produced in three sizes, the largest of which measures 9 7/16 x 5⅛ in, height. It can be furnished in open, closed or explosion-proof housings and can be flange or foot mounted. Torq Engineered Products, Inc., Bedford, Ohio.

For more information—
Circle 34, inside back cover

Servo for 150 C

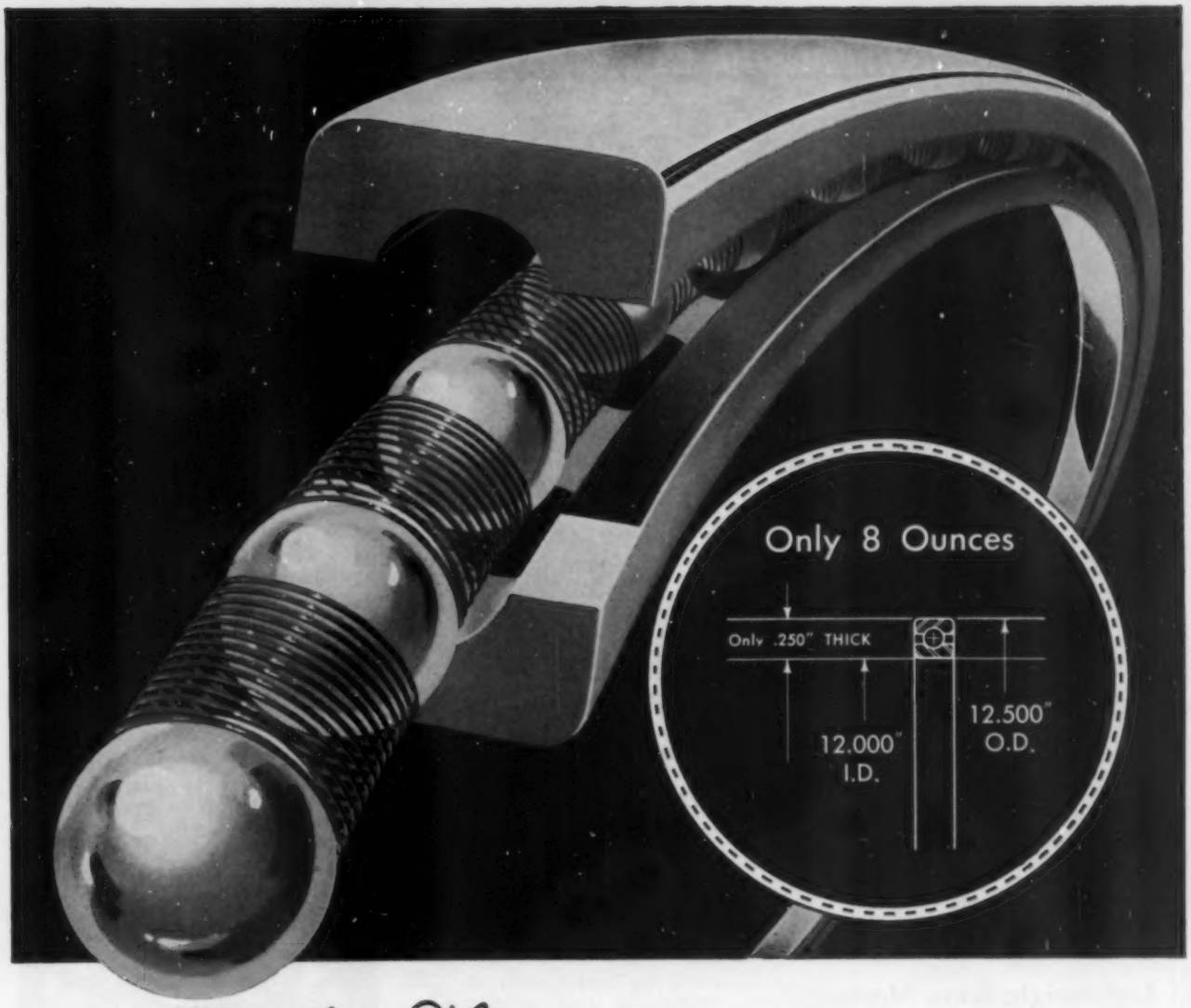
A high temperature 400 cps servo motor which also meets Mark 7 specifications withstands operating temperatures up to 150 C, continuous 1000 hr. Extremely small air gap is said to result in top performance for a high torque-to-inertia ratio. Humidity protection is given by encapsulating the entire stator in a thermosetting resin to meet MIL-E-5272A. Series 2287 has stainless steel ball bearings and meets MIL-S-17087 specs. Dimensions are 1.437 x 1.640 in. length. Weight is 8 oz, minimum stall torque 1.45 in-oz, no-load speed 4800 rpm, min, and power input at stall is 12.2 w, total. John Oster Mfg. Co., 1 Main St., Racine, Wis.

For more information—
Circle 35, inside back cover

Indicating Pushbuttons

This line of pushbutton switches contains integral indicator lights, covering a size range of ½ to 1 in. mounting hole size and voltages up to 220 v. A variety of internal circuits are available including units incorporating switching contacts and

CONTINUED ON PAGE 230



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54 RS.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 3/16" and in bore diameters from 5" to 40".

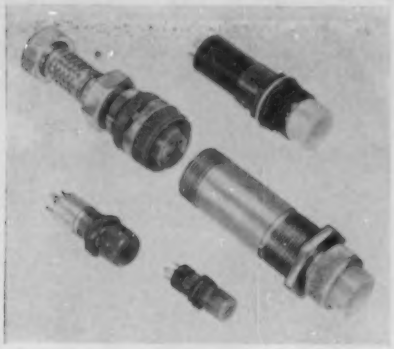
K-554

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

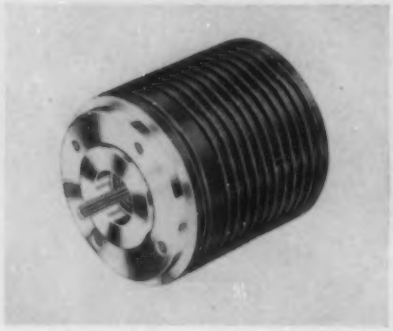
All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings



terminals isolated from the lamp or indicating circuit. Marco Industries Co., 207 S. Helena St., Anaheim, Calif.

For more information—
Circle 36, inside back cover



Lightweight Servo Motors

The largest of the three standard sizes in which these motors are available is 1.75 in. dia, and it weighs 3 oz. The unit operates normally at ambient temperature of 125 C. Many of these units are available for operation on 400 cps current, and a number of them for 60 cps current. The stators of these motors are embedded in an insulating compound of high dielectric strength and high temperature stability. G-M Laboratories, Inc., 4300 N. Knox Ave., Chicago 41, Ill.

For more information—
Circle 37, inside back cover

Shaded Pole Motor

This motor is 5½ in. dia and is supplied in 1/25 to 1/4 hp ratings. For designs with limited space the motor design can be supplied as short as 2½ in. in 1/15 hp. The unit is double-impregnated with heat-reactive insulating varnish which provides outstanding moisture resistance. The stator is insulated with Mylar. It is suggested that this motor be used in air conditioning units, fans, blowers and furnaces. Marco Industries, Inc., 830 Terrace Blvd., Depew, N. Y.

For more information—
Circle 38, inside back cover

General Purpose Open-Type Motor

A general purpose aircraft-type motor designed to provide a lightweight drive for blowers, pumps, actuators weighs 3.5 lb. The motor delivers ¼ hp continuously at 7200 rpm. Motor is designed for three-phase, 400 cps, 200 v operation.

The motor's starting torque is 4.0 in-lb. Self-ventilated, the motor operates in sea level ambient temperatures from −55 C to 71 C. Mounting bracket and take-off shaft are standardized in accordance with military specifications. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 39, inside back cover

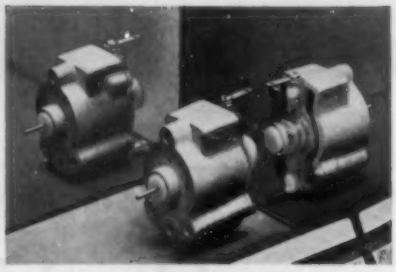
Miniature High Speed Solenoid

A miniaturized single-coil high-speed work solenoid requires 5 millisec to reach saturation in any altitude range. It is designed to meet applicable requirements of MIL S-4040 A. With ambient temperature range of −65 F to 200 F, the new

solenoid can be internally pressurized at 3000 psi and is designed for a life of 200,000 cycles.

Minimum pull available at the beginning of the stroke is 0.50 lb at 0.2 amp, 78 F and 28 v, dc. Stroke is 0.070 in; plunger weight is 0.015 lb. Weighing 0.1 lb, the Model 10-114 is 1.075 x 0.782 in. dia. Carruthers & Fernandez, Inc., 1501 Colorado, Santa Monica, Calif.

For more information—
Circle 40, inside back cover



Self-Governed D-c Motor

Development of a controlled speed motor weighing less than 3 oz has been announced. It measures 1⅜ x 1¾ x 1⅛ in. The motor has a self-contained governing device and a speed of 1800 rpm. Speed regulation in one application is within 1 per cent from idling to full load and over a range of battery voltages from 6.4 to 4.6 v.

The new motor is suggested for portable direct-current tape and wire recorders, radio-phono combinations, straight phonograph, electrically driven movie cameras, timers, instrumentation. The motor has a three-pole armature, permanent magnet field,

CONTINUED ON PAGE 232

1/3 OFF

NO BARGAIN
FOR UNIFORM FLAT SPRING
PERFORMANCE

According to the deflection formula for flat springs, the deflection or load of flat springs will vary in direct proportion to the third power of the thickness.

This means that flat springs made from .010" ordinary commercial flat rolled high carbon strip (standard gauge tolerance ± .001") can be off as much as 33%, plus or minus, in deflection or load value.

Where the nature of the service calls for more uniform spring performance, CMP produces restricted thickness tolerances which make possible load tolerances of ± 10% or less. CMP is regularly supplying such uniform restricted tolerances for special flat spring applications, multiple-station progressive die forming and other specialized end products where uniform, extra-close gauge accuracy reduces fabricating costs and waste and provides better product performance.

If you have a flat spring problem, you are invited to avail yourself of CMP's specialized knowledge and experience in this field.

CMP
WHERE YOU CAN GET SPECIFIC SPECS. FOR SPECIFIC JOBS

LOW CARBON
HIGH CARBON
Annealed or Tempered
STAINLESS
ALLOY
ELECTRO ZINC COATED

PRECISION COLD ROLLED C M P STRIP STEEL

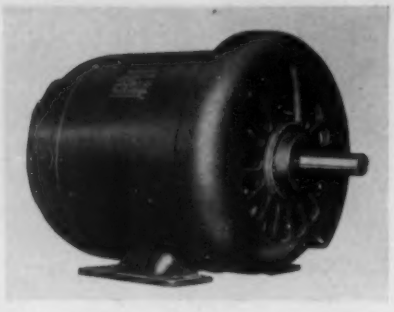
the Cold Metal Products co.

GENERAL OFFICES: YOUNGSTOWN 1, OHIO

PLANTS: YOUNGSTOWN, OHIO AND INDIANAPOLIS, IND.
SALES OFFICES: New York • Cleveland • Detroit • Indianapolis
Chicago • Los Angeles • San Francisco

zinc die-cast body. The armature is shock mounted in self-aligning ⅜ in. dia bearings. Kinder Co., Box 686, S. Milwaukee, Wis.

For more information—
Circle 41, inside back cover



Totally Enclosed Fhp Motor

This ½ hp motor is recommended for use in dirty/dusty, fume and mist-laden atmospheres. It meets all NEMA requirements.

Ventilating fan is integrally cast with rotor, acting as a rotating seal and providing cooling when operated in either direction. Century Electric Co., 1806 Pine St., St. Louis Mo.

For more information—
Circle 42, inside back cover

Brake Motor

Built to the rerated NEMA specifications, this motor has a through-shaft extension for hand cranks, tachometers or other accessories. A direct-acting magnetic disc brake is used which can be connected either directly to the motor terminals or to a separate power supply. As a safety measure the brake will set and hold in the event of power failure or low voltage by means of mechanical spring action. The cast-iron frame is heat-seasoned to prevent warpage. Ratings are from 1 to 30 hp. The motors are available with standard, undersize, or oversize brakes. U. S. Electrical Motors, Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

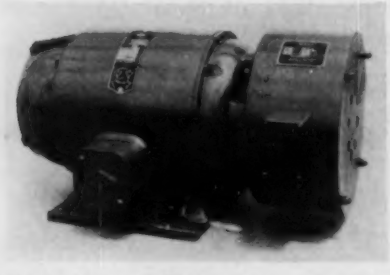
For more information—
Circle 43, inside back cover

Germanium Diffused Junction Rectifiers

A series of germanium power rectifiers now available in production quantities for general industrial use are said to have a reverse current at least 20 per cent lower than RETMA specifications. They are particularly recommended for blocking, magnetic amplifier and magnetic control applications. They can replace thermionic diodes in computers, and, in addition, their low capacitance permits the passage of frequencies up to 50 kc, making them suitable for such uses as carrier-type servo amplifier rectifiers.

The respective rms input voltages for the Models 1N91, 1N92, 1N93, and the 1N368 under inductive load are 70, 140, 210, and 140 v. D-C output currents are respectively 150, 100, 75, and 100 ma and peak inverse a-c voltages 100, 200, 300 and 200 v. Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J.

For more information—
Circle 44, inside back cover



Frequency Changer 60 to 420 Cps

Supplying a constant 420 cps, with output frequency as invariable as the input, this motor is of the synchronous type, direct-coupled with a 420 cps generator. Resulting combination is free of brushes, exciter, slip rings, yet delivers as constant a 420 cps frequency as the input 60 cps. Without any regulator or auxiliary of any kind, unit will maintain output voltage to better than 2 per cent for a given load.

Converters are available in this design in 150 va to 5 kva ratings, with any desired combination of single or three-phase input and output. All standard output voltages are available, special or multiple voltages on special order. Georator Corp., Manassas, Va.

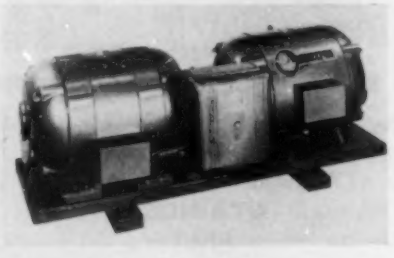
For more information—
Circle 45, inside back cover

Transistorized Power Supply

This unit will supply filtered d-c voltages of over 5000 v from one 1½ v flashlight battery. Models are available that produce higher voltages. The power supply weighs a few ounces and can be built in any size or form and can be included in any type of printed circuitry.

Drain approximates shelf life. It is completely encapsulated for moisture and temperature proofing. Universal Atomics Corp., 19 E. 48 St., New York, N. Y.

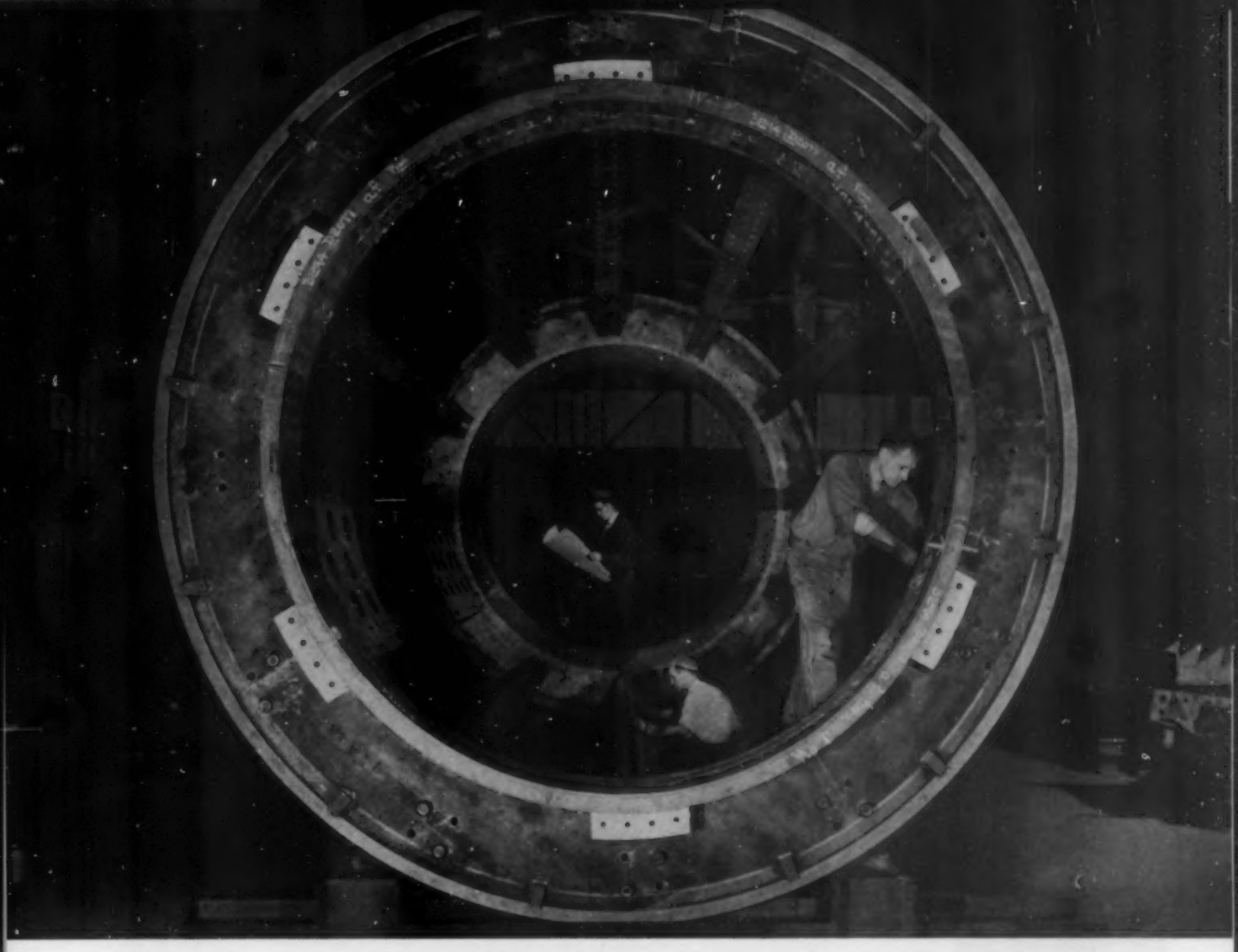
For more information—
Circle 46, inside back cover



Power Supply for Ultrasonic Processing

These alternators are capable of supplying economical power for energizing multiple arrays of above audible sound generating transducers needed to irradiate materials and products being processed. This unit's 230-v, 20,000 cps single-phase, 5 kw generator is driven by a 15 hp, three-phase, 60 cps, 220-440 v, a-c squirrel

CONTINUED ON PAGE 234



SSW forged rings take rugged, heavy wear of Heyl & Patterson coal breakers

SSW forged rings consistently have proven to Heyl & Patterson, Inc., Pittsburgh, they can take the rugged, heavy wear of their coal breakers. They've found Standard Steel's inherent uniform structure and high-quality analysis makes for longer-lasting, failure-proof life of these rings.

This 19-ft. long, 35-ton coal breaker revolves on two 13-ft. diameter endless forged steel tires. It's capable of producing approximately 600 tons of coal per hour, turning at 15 rpm. And Heyl & Patterson can count on these precision-treated rings to withstand effectively abrasion and wear of such heavy-duty operation.

In addition the structural uniformity of these rings enables them to simplify greatly fabrication of their breakers.

You too can improve your product, increase production with Standard Steel forgings. We have a new folder on forged weldless rings and flanges which tells you how. Act today by using the coupon conveniently located below.

Standard Steel Works Division

BALDWIN-LIMA-HAMILTON

Dept. 8835, Standard Steel Works Division
Baldwin-Lima-Hamilton Corporation, Burnham, Pa.

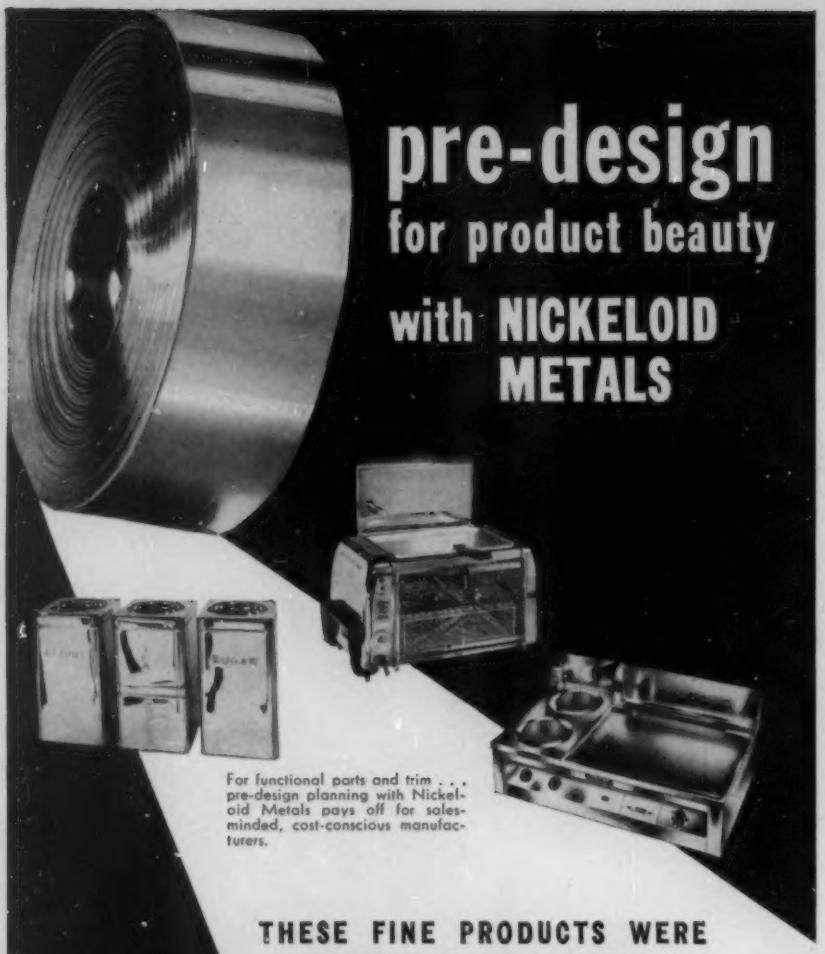
Please send me new Standard Steel Works folder containing detailed information on Forged Weldless Rings & Flanges.

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State ____



For functional parts and trim . . . pre-design planning with Nickeloid Metals pays off for sales-minded, cost-conscious manufacturers.

THESE FINE PRODUCTS WERE DESIGNED *AROUND* NICKELOID METALS

In the pre-design stage . . . before investing in tools and dies . . . consider pre-plated Nickeloid Metals. Take full advantage of their inspiring design potential and basic production savings, too. PRE-plated in uniform, quality-controlled finishes of chrome, nickel, copper or brass on base metals of steel, zinc, copper, brass and aluminum — Nickeloid Metals require no cleaning, plating, polishing. Just fabricate the parts and assemble. Eliminate 3 out of 5 basic manufacturing steps; save time, reduce costs, increase output.

MAR-NOT PROTECTION

To protect the brilliantly finished surface during drawing and forming operations, and in handling, Nickeloid Metals are available with MAR-NOT — a protective covering that affords absolute protection until final assembly, then may be peeled off. **Write for full details.**

SHEETS • COILS • STRIPS

NICKELOID METALS
SINCE 1898

AMERICAN NICKELOID CO.

PERU 4, ILLINOIS

Electric Power, Control

cage induction motor. It is said that it will energize up to ten submersed 400-w transducers of any type strategically located in the chemical system. Each transducer will cause copious cavitation through a large field in the solution. The explosive forces caused by the collapse and formation of millions of entrapped vapor bubbles at the rate of 20,000 times per second is in the order of several hundred atmospheres pressure. Acoustica Associates, Inc., Glenwood Landing, N. Y.

For more information— Circle 47, inside back cover

High-Torque Magnetic Brake

This magnetic brake for use in the 25 to 50 hp range with both the old and newly re-rated NEMA frame sizes requires up to 6 in. less clearance for housing removal than the old style brake it replaces. Overall length has been reduced as much as 2¼ in. and weight reductions of more than 20 per cent are reported to have been effected. Two sizes are available, rated at 125 and 175 lb-ft torque. This brake may also be supplied for floor mounting. Stearns Magnetic, Inc. Milwaukee 46, Wis.

For more information— Circle 48, inside back cover

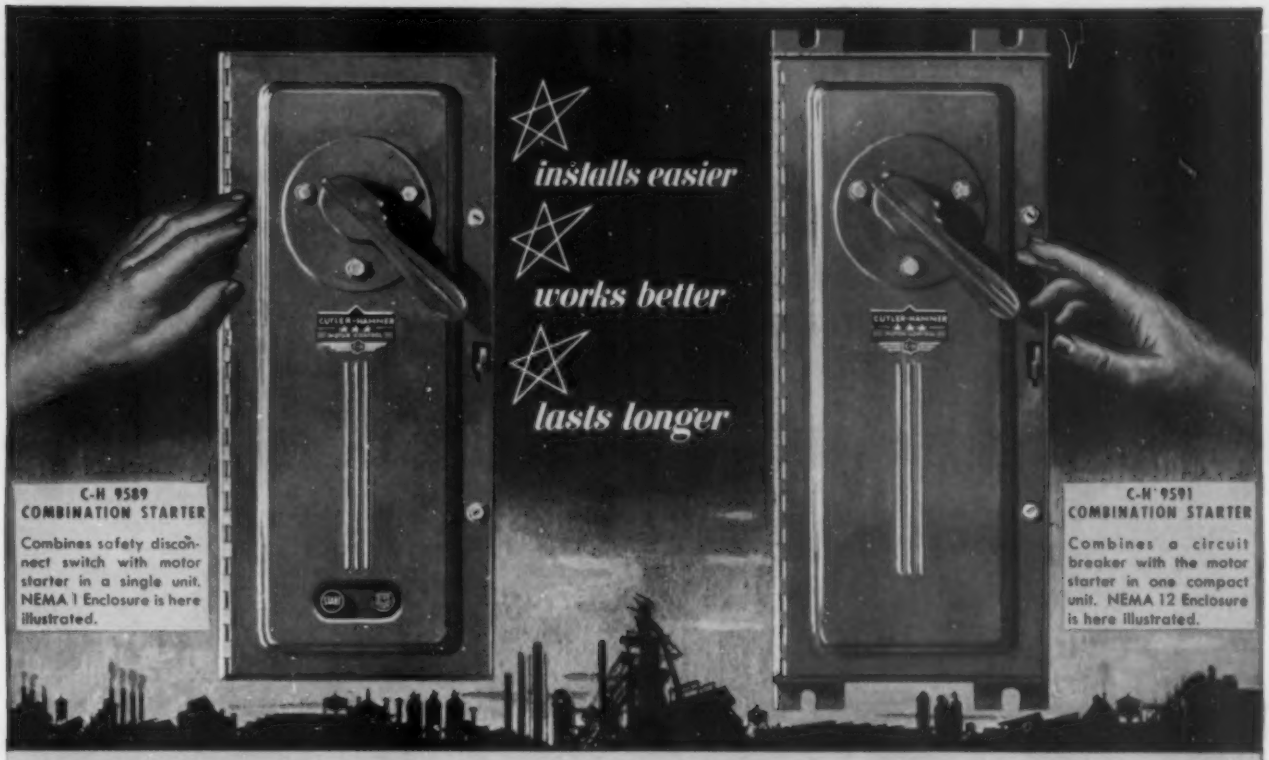
Voltage-Frequency Control

Integrated single packages for the regulation of both voltage and frequency of motor-alternator sets and inverters are presently available in two models, for 60 cps outputs, and for 400 cps.

The control permits conversion from any d-c source voltage to any a-c

(Continued on page 238)

New Cutler-Hammer Three-Star Combination Starters offer industry important new economies

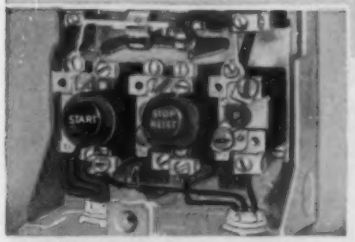

installs easier
works better
lasts longer
C-H 9589
COMBINATION STARTER
Combines safety disconnect switch with motor starter in a single unit. NEMA 1 Enclosure is here illustrated.
C-H 9591
COMBINATION STARTER
Combines a circuit breaker with the motor starter in one compact unit. NEMA 12 Enclosure is here illustrated.

Convenience and economy are basic advantages of combination starters. Users everywhere say the new Cutler-Hammer ★ ★ ★ Combination Starters bring these basic advantages to new high levels of importance. Contact life is so amazingly improved that maintenance care is *never* needed in all normal uses. Adjustable load sensing coils permit motors to work at top capacity without hazard to provide maximum production without needless work interruptions. And the widely praised Cutler-Hammer exclusive, full three-phase overload protection in standard combination starters, is optional at slight additional cost.

The three silver stars stand for three new standards

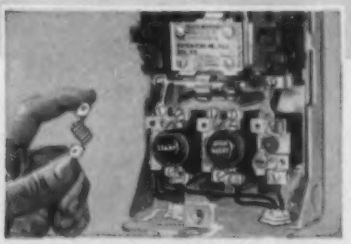
CUTLER-HAMMER
★ ★ ★
MOTOR CONTROL
C-H

Compare the performance and economies of these remarkable new Cutler-Hammer Three-Star Combination Starters with any you have ever known. Cutler-Hammer Bulletin 9589 Combination Starters incorporate rugged disconnect switches of advanced design (fused or unfused). Cutler-Hammer Bulletin 9591 Combination Starters are equipped with circuit breakers. Your nearby Cutler-Hammer Authorized Distributor is stocked and ready to serve you. Order from him today.
CUTLER-HAMMER, Inc., 1332 St. Paul Avenue, Milwaukee 1, Wisconsin.



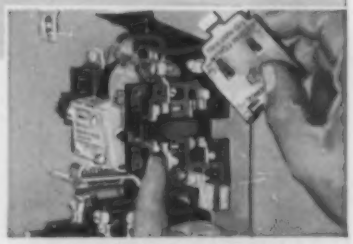
Full Three-Phase Protection

Only *three* overload relays can give complete three-phase protection to avoid motor burn-outs and their costly interruptions to production. And *only* Cutler-Hammer offers this complete three-phase protection in standard combination starters. You pay only for the third relay, nothing extra for special engineering or special enclosures.



Adjustable Load Sensing Coils

The accurate adjustment of overload protection permits motors to work harder without damage to motor windings. This is more important than ever with the newer type small frame motors. Adjustable load sensing coils in these new starters provide 3% loading accuracy instead of the 10% to 12% accuracy in competitive control.



Superlife Vertical Contacts

Experienced control users insist on dust-safe vertical contacts. And now the famous Cutler-Hammer vertical contacts have been doubly improved. First, their new lightweight design cuts bounce to reduce arcing. Second, any arcing that might occur is now pressure-quenched. Compare performance and see the difference.

FULTON SYLPHON

BELLOWS HEADQUARTERS,

Seamless Metal Bellows

The Sylphon Bellows was originated by Fulton Sylphon over 50 years ago. Its unique one-piece expansible and collapsible design is used widely for diaphragm effects, flexible connections and expansion chambers.

All Types, Sizes and Metals

Fulton Sylphon Bellows are all designed to specific customer requirements. They are furnished in a limitless number of sizes, a complete range of types and metals and with many different reaction characteristics.

On-Call Engineering Service

Fulton Sylphon Bellows Engineers are strategically located in all industrial areas of the country. This "near-by" service is on-call to help you determine the right bellows metal, correct bellows charge and most economical design for your specific application.

U.S.A.

For the conversion of pressure effects into controlled movement, the operation of valves and switches in response to temperature change, the absorption of thermal or pressure expansion or the absorption of vibration—a seamless metal bellows may be your best design solution. The best way to find out, is to consult a Fulton Sylphon engineer. He'll focus more than 50 years experience in bellows engineering on your problem.

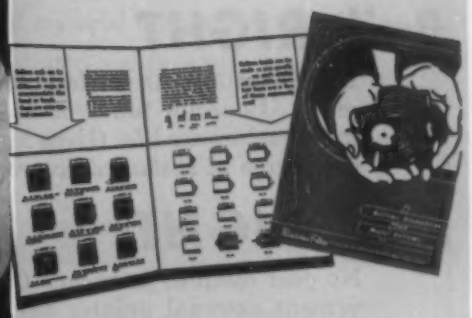
Robertshaw-Fulton
CONTROLS COMPANY
FULTON SYLPHON DIVISION

Assemblies and Complete Devices

By purchasing complete bellows assemblies and devices rather than buying bellows units, many manufacturers achieve significant production economies. Fulton Sylphon is singularly equipped to design and produce complete assemblies at low cost.

On-Time Delivery - No Delays

Fulton Sylphon's mass production facilities are geared to good service. Exceptional quality control techniques often eliminate any need for customer's in-coming inspection. Customer service and shipping follow-through assure on-time delivery without costly delays.



BASIC BELLOWS ENGINEERING
and ways Fulton Sylphon can serve you are described in this 32 page Bellows Catalog. It makes profitable reading . . . use the handy coupon to get your free copy.

FULTON SYLPHON DIVISION
Knoxville 1, Tennessee

☐ Please have a Bellows Engineer call me for an appointment.

☐ Send me Bellows Catalog No. VP-1400

Name_____

Company_____

Address_____

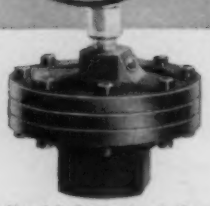
City_____ State_____

ACCO product

Helicoid Gages

Why HELICOID is the Quality Gage for every pressure indicating service

Acaloy Case Helicoid Gage
Suitable for tap water, steam, inert gases, oils, coal gas and many chemicals.



Helicoid Chemical Gage
Suitable for chemicals and other viscous liquids which might corrode or clog Bourdon tube.

Acaloy Square Flush Case
This is a weather-proof case and ideal for use in symmetrical panels.

Built RIGHT

Exclusive HELICOID gearless movement. Bourdon tubes of maximum endurance life. Gives highest degree of *sustained accuracy*.

Stay RIGHT

No gear teeth to wear out. Convenient external pointer adjustment. Protected from sudden overpressure or pressure reduction.

Sold RIGHT

Experienced HELICOID gage engineers are available to help you choose the gage you need. Distributors are conveniently located. Write for the name of the one nearest you.

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-D Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value

Electric Power, Control

output voltage, within the ratings of the controlled machine. Units can be built for any power frequency. Standard units are reported to regulate both output voltage and frequency to within ± 2 per cent. Electric Regulator Corp., 314 Pearl St., Norwalk, Conn.

For more information—
Circle 49, inside back cover

Auxiliary Power Supply

A miniature, encapsulated power supply that contains no vacuum tubes is said to be finding wide application with special packages of one to three-stage vacuum tube circuits.

In order to withstand encased vibration and shock the components are in a lightweight, foam-type thermosetting resin, hermetically sealed.

This new instrument is 2⅜ x 3⅛ x 4¼ in. long and mounts by means of four studs located on its under surface. The power supply operates from a 115 v, 60 or 400 cps line, and provides two unregulated outputs: 150 v, dc, at 6 ma as a plate supply, and 6.3 v, ac, (center-tapped) at 0.6 amp as a filament supply. Ripple is kept below 1 mv at 400 cps, and 5 mv at 60 cps. Trio Laboratories, Inc., 3293 Seaford Ave., Wantagh, L. I., N. Y.

For more information—
Circle 50, inside back cover

Power Supply for Use With 28 V, Dc

This supply is built for continuous duty in laboratory or production testing, and in original equipment. The unit employs a selenium rectifier, and has sufficient filtering to operate relays, solenoids, motors and many

(Continued on page 245)

STOP LINE KINKS WITH NEW LOW COST

CHIKSAN JR. SWIVEL JOINTS

ACTUAL SIZE ¾"

Need free swiveling action on air, coolant, liquid or hydraulic lines?

Then by all means investigate the new Chiksan Jr. Swivel Joints. Their astonishing low price is quickly repaid a hundred-fold in labor and material replacement costs. Chiksan Jr. No. 2, controlled torque design, illustrated above, is for use on flexible lines which are required to lock in any position.

Chiksan Jr. No. 1. Permanent clamp design for use on lines where free swiveling action is required.

- Available in ½" and ¾" sizes.
- Nipples and sleeve are Zamak #5. Resists corrosion. High tensile strength.
- Cadmium-plated clamps are rust resistant.
- "O" Rings will handle most fluids, oils, air, water. Other "O" Rings for special services.
- Maximum pressure 125 psi, maximum temp. 225° F.
- Select either permanent clamp or controlled torque design.
- Immediate delivery. Quantity prices.

CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

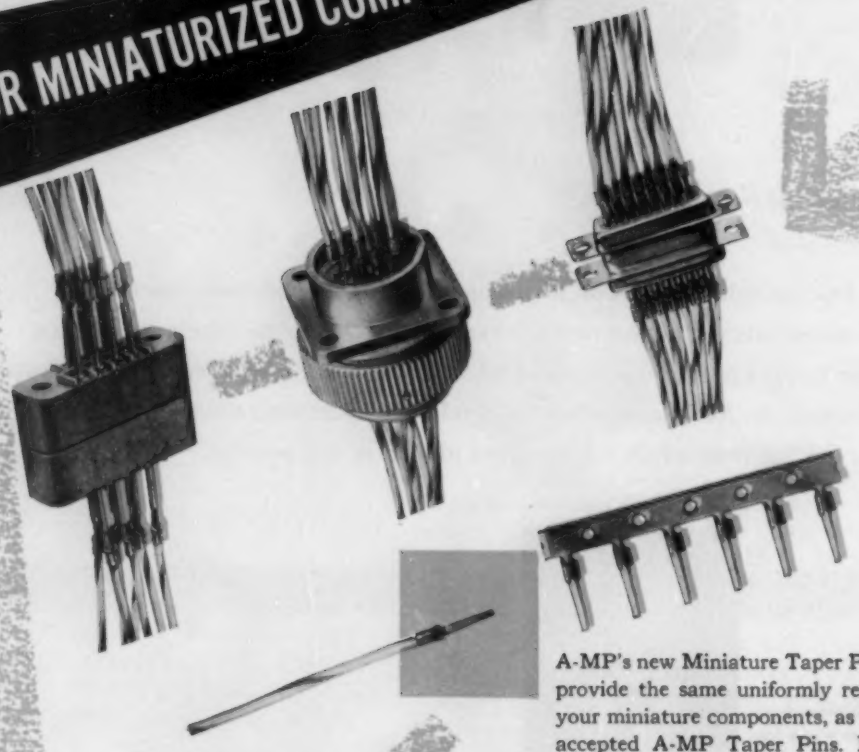
CHIKSAN COMPANY — BREA, CALIFORNIA • CHICAGO 3, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif., Newark 2, N. J. • Chiksan of Canada, Ltd., Edmonton, Alta.

Announcing A-MP®

MINIATURE *TAPER PINS*

FOR MINIATURIZED COMPONENTS!



A-MP's new Miniature Taper Pins, shown here actual size, provide the same uniformly reliable wire connections for your miniature components, as the larger, widely used and accepted A-MP Taper Pins. Miniature Taper Pins are applied to wire with A-MP Automatic Machines at speeds up to 4000 per hour. They are then inserted into components quickly and easily with A-MP CERTI-LOK Insertion Tools. Miniature Taper Pins are available for wire sizes #26 to #20.

A-MP®

©A-MP

Send today for your copy of "A-MP's Creative Approach to Better Wiring"

AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.
In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New Crack-Free Chromium Plate gives superior protection

Structurally perfect finish from stress-free chromium

Differences in the structure of ordinary chromium and Crack-Free Chromium deposits are shown by the photomicrographs below.

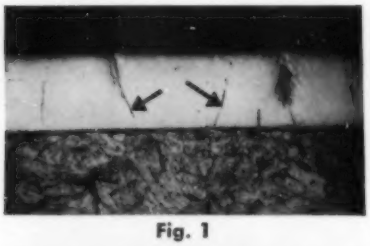


Fig. 1

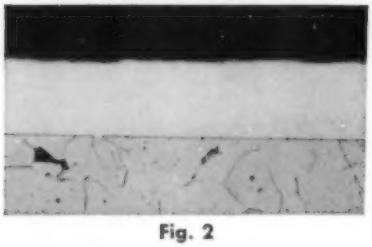


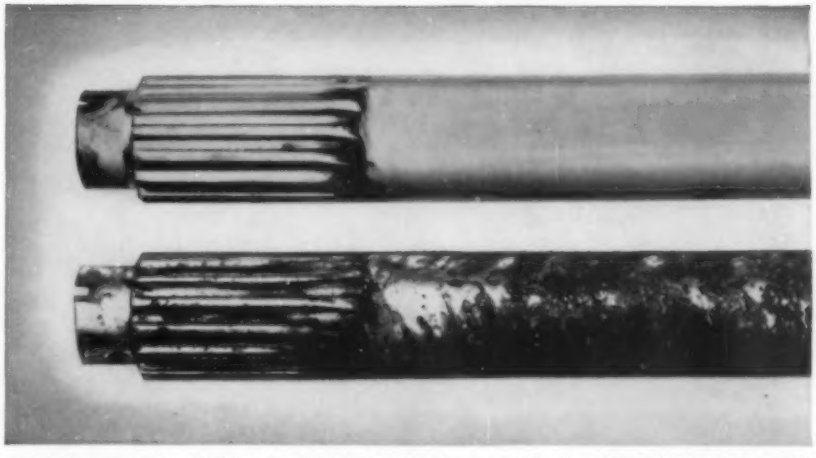
Fig. 2

Figure 1 shows a cross section of etched ordinary chromium .00125" thick, with part of its network of cracks. Note that some cracks extend through the deposit to the base metal, providing an unimpeded path for corrosives.

Figure 2 shows a section of etched Crack-Free Chromium also .00125" thick. Note the complete absence of cracks.

• • •

UNITED CHROMIUM DIVISION
METAL & THERMIT CORPORATION
100 East 42nd Street, New York 17, N. Y.
Waterbury 20, Conn. • Detroit 20, Mich.
East Chicago, Ind. • El Segundo, Calif.
In Canada:
United Chromium Limited, Toronto 1, Ont.



Upper steel shaft, with 0.0005 inch of Crack-Free Chromium, was virtually unaffected after 100-hour salt spray test. Surface of lower shaft with 0.0005 inch of ordinary chromium was completely covered with rust.

A basic need has at last been satisfied. A chromium deposit which gives better protection against corrosion is now obtainable by means of a new process developed by United Chromium.

Unichrome Crack-Free Chromium Plating produces more ductile deposits which are relatively free from internal stress. Thus, deposits do not crack as they are built up to hard plating thicknesses. In this respect they are unlike ordinary chromium which develops cracks, providing corrosives with paths to the underlying metal.

EFFECTIVE PROTECTION DIRECTLY ON STEEL

The photograph above shows that .0005" of Crack-Free Chromium plated directly on the steel prevented rusting of shafts subjected to 100 hours of salt spray, while the same thickness of ordinary chromium failed completely.

In other corrosion tests, parts plated with .0003" of Crack-Free Chromium were as good as new after a full year at 100% relative humidity and 110°F whereas parts with ordinary chromium were entirely covered with rust in days.

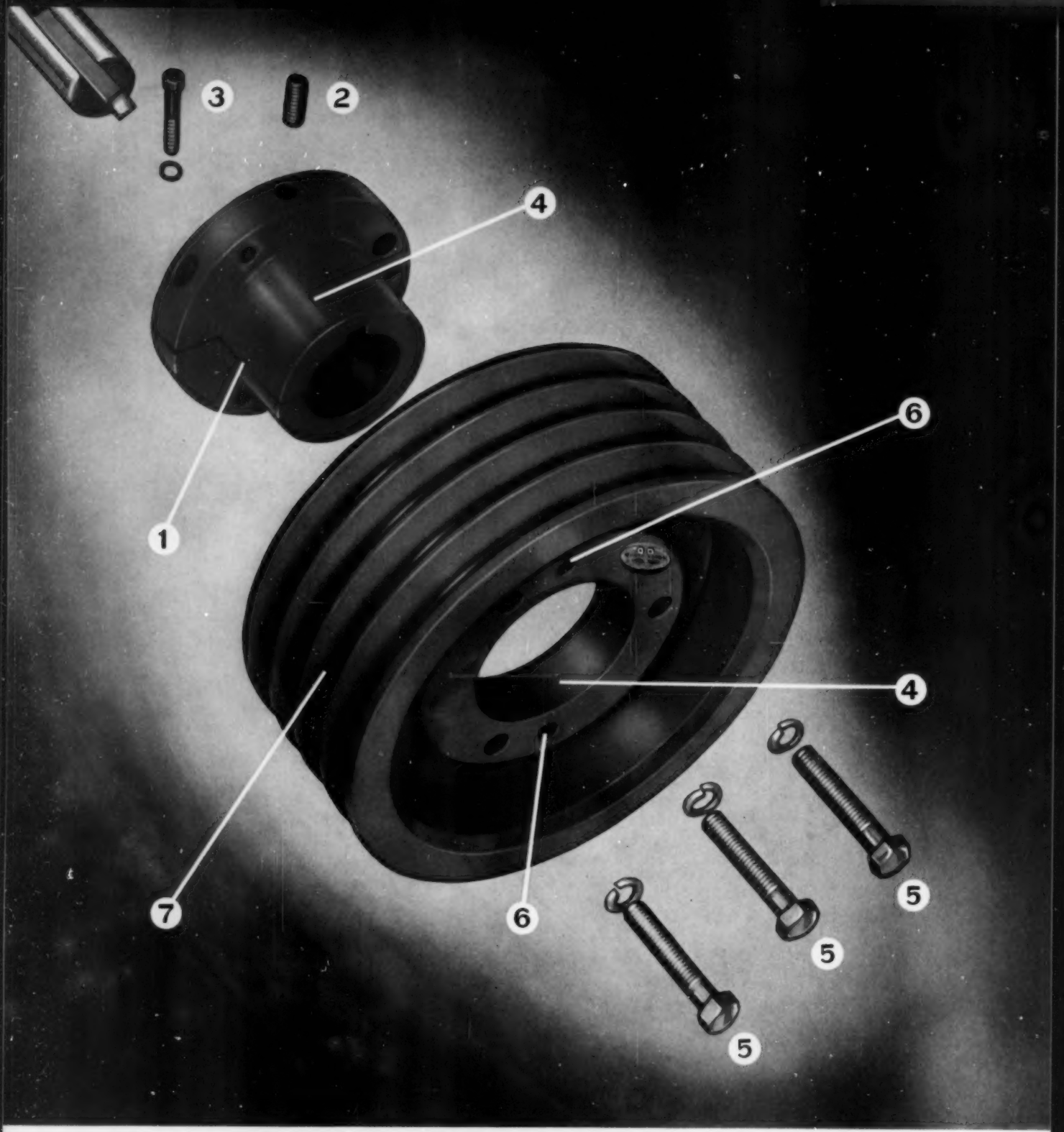
For many decorative applications, Unichrome Crack-Free Chromium can be plated directly on steel or zinc base die castings, eliminating need for scarce nickel.

OTHER BENEFICIAL PROPERTIES

Crack-Free Chromium deposits are hard (500 to 700 Knoop), have a low coefficient of friction, and a non-galling, non-seizing surface. The plate has superior ductility and resistance to thermal shock. Unusual leveling action is provided by the solution.

Its grayish, matte finish needs buffing for high luster, but this is done as readily as buffing dull nickel. Attractive two-tone effects can be produced by buffing some areas, leaving others as plated.

Unichrome Crack-Free Chromium has already proved its advantages for hard chromium plating and certain decorative applications in successful commercial operations. Bulletin CFC-1 gives more details. Send for your copy.



EXPLODED VIEW of Worthington QD Sheave shows design features that make it industry's first choice.

1. **COMPLETELY SPLIT QD HUB** holds shaft tightly under heaviest shock loads.
2. ***CUP POINT SET SCREW** in QD hub keeps shaft key in position.
3. ***CLAMP SCREW** secures hub in proper alignment on shaft when mounting sheaves.
4. **TAPERED FIT** between hub and sheave allows easy-on, easy-off, hold-tight action.
5. **PULL-UP BOLTS** draw sheave on to hub to produce positive fit on shaft.
6. **TAPPED HOLES** in sheave permit pull-up bolts to be used as jack screws to break cone grip when removing sheave.
7. **GROOVE CROSS-SECTIONS** are accurate and uniform so that each V-belt seats properly, pulls evenly.

***All Worthington-Manufactured QD Heavy-Duty Hubs incorporate these exclusive features.**

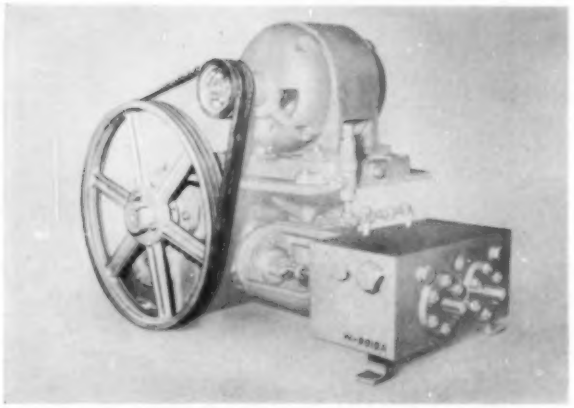
Who says all sheaves are alike?

Nobody who ever saw the Worthington QD, we wager.

Big difference between the QD (that's short for quick-detachable) and ordinary sheaves is this: the QD is easiest to get on, easiest to get off, yet always grips tightly on the shaft.

Those are the big reasons why design engineers specify more QD's than any other sheave — why the QD will do a *better* job on *your* product.

More reasons for standardizing on the QD

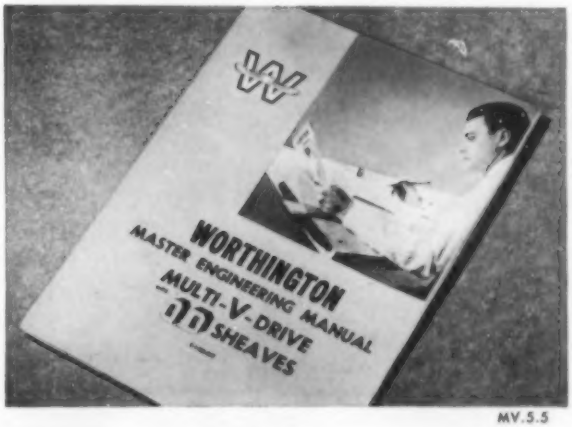


SCIENTIFIC DESIGN of Worthington QD Sheaves not only provides more efficient transmission of power but actually adds to the looks of your product. What's more, I-beam construction of the QD DriveN sheave provides greater strength with less weight. You'll find Worthington QD Sheaves a dependable source of trouble-free mechanical power transmission. The large variety of immediately available standard sizes and ratings, for A, B, C, and D section V-belts, makes for a simple, economical solution to your design problem.

PROMPT SHIPPING SERVICE. Thirteen factory warehouses with stocks covering over 100,000 V-belt drive combinations, from ½ to 600 horsepower, support more than 250 distributor outlets. These shipping centers can fill your requirements *fast*.

Warehouses Located at: Kearny, N. J. • Oil City, Pa. • Portland • San Francisco • Los Angeles • Denver • Tulsa • Ft. Worth • Houston • New Orleans • Chicago • Cleveland • Atlanta, Ga.

GOOD NEWS FOR DESIGN ENGINEERS! Now, with Worthington's new 100-page "Master Engineering Manual," you can select the right sheave and V-belt combination for your equipment in *three minutes*. Easy-to-use tables take all the complications out of sheave selection — require only simple arithmetic. Be sure to write for your copy today. It's free, of course. Worthington Corporation, Mechanical Power Transmission Division, Section MV.5.5, Oil City, Pa.



MV.5.5

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

Profit with papers by Mosinee

Mosinee impregnating papers replace steel—when treated with synthetic resins to form light, strong, better insulated refrigerator door panels. Mosinee works with many manufacturers to develop impregnating papers of special qualities. In this case, characteristics desired are strength and moldability to take deep draws.

Cable wrap of special Mosinee paper winds easily, twists uniformly. Mosinee moisture resistant, extra-strong, electrical cable wrap offers a plus value. Mosinee specialized production controls insure uniformity, minimize problems in high speed twisting and cable wrap operations.

Find out how you can get "MORE PROFITS with PAPER"—for laminations, insulation, packaging, protection, fabricating or processing

Mosinee patented reinforced paper simplifies building construction. Easy to handle Mosinee reinforced papers with steel mesh reinforcing attached, replace wood forms for pouring lightweight concrete floors. This is only one of many instances in which Mosinee cooperated in developing new papers to improve processing or production.

THAT's the theme of a growing number of concerns and industries who have worked with Mosinee experts. They've found Mosinee's more than a quarter century of experience particularly valuable in developing special papers to perform specific functions. They've discovered that Mosinee special papers help complete their product or process faster, easier and usually at less cost.

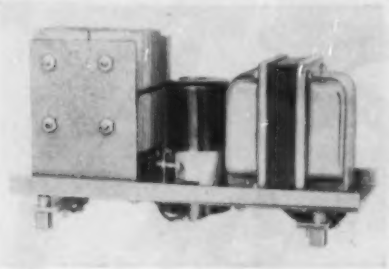
If you'd like to get a general idea of how Mosinee special papers can be developed or adapted to solve your particular product, production or packaging problems — write or see your Mosinee representative. Find out how you, too, can profit more with papers by Mosinee.

MOSINEE PAPER MILLS COMPANY
DEPT. PE, MOSINEE, WISCONSIN

Mosinee

— specialist in industrial paper technology — makes fibres work for industry.

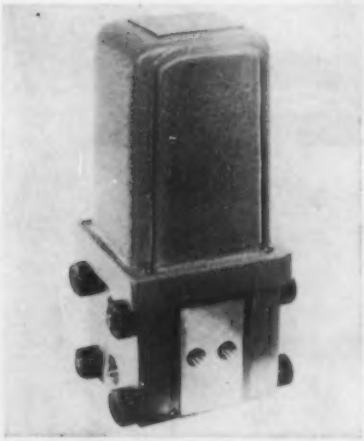
Electric Power, Control



other components. Output voltage can be adjusted for less than full load by means of extra transformer taps, which are brought to a convenient terminal board.

Input is 115 v, 60 cps. Output is 28 v, dc, 2 amp; ripple: 2.2 v, max. Dimensions are 3½ x 9⅝ in. Weight is 6 lb. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.

For more information—
Circle 51, inside back cover



Force-Balance Instrument

A pneumatic force-balance flow transmitter for accurate, instantaneous transmission of differential pressure has no working parts in contact with the process fluid. Fluid pressures are exerted on outside surfaces of two diaphragms which transmit pressure differential through a sealed-in oil chamber between them.

Internal hydraulic temperature compensation gives stability to temperature variation.

The range of the transmitter is continuously adjustable from 0-20 to 0-200 in. of water and has an output of 3 to 15 psi. Pressure rating is 1500 psi and temperature rating is −20 F to 300 F. The transmitter

(Continued on page 250)

get this KEY to lower assembly costs

There are new opportunities for cutting assembly costs in the "Key Locking" feature of KELOX Inserts and Studs. You can improve your product and reduce assembly costs with KELOX because these fasteners—

1. Provide a positive lock between insert or stud and parent body.
2. Provide higher stress allowable per space required.
3. Are simple to install and remove.
4. Make maximum use of tapped hole.
5. Afford considerable reduction in assembly weights.
6. Save space and improve product design.
7. Can be serviced in field without special tools.
8. Require no special threads.

KELOX Fasteners are part of a family of universally used PHILLIPS PRODUCTS that are designed, developed and distributed by a world-wide organization.

This highly specialized, technical group will be glad to assist you with your fastener problems. Use coupon below to get more facts on KELOX!

KELOX

Fasteners, Inc.

580 Fifth Avenue
New York, New York

SALES REPRESENTATIVES—

Universal Fasteners Co.
Centerville Road, P. O. Box 449
Sturgis, Michigan

F. D. Barringer Company
542 Spring Street, N.W.
Atlanta 3, Georgia

Monogram Manufacturing Co.
8557 Higuera Street
Culver City, California

D. R. & W. Technical Service Company
P. O. Box 4
East Hartford, Connecticut

Scott Fittings Limited
339 Bering Ave., P. O. Box 169
Toronto 18, Canada

3395

Please send me technical data on KELOX Inserts and Studs

Name ..... **Title** .....

Company .....

Address .....

Product being assembled .....

maximum process utilization

with

MADISON-KIPP

zinc and aluminum die castings

Die casting as a process has marked advantages in providing lightness, strength and stability in parts that can be cast to dimensions requiring a minimum of machining.

Seasoned skill, however, is involved in getting maximum process utilization as in the Madison-Kipp casting here illustrated, developed with the close cooperation of the user and the die designer.

Please clip this ad as a reminder to contact us when you have die casting requirements.

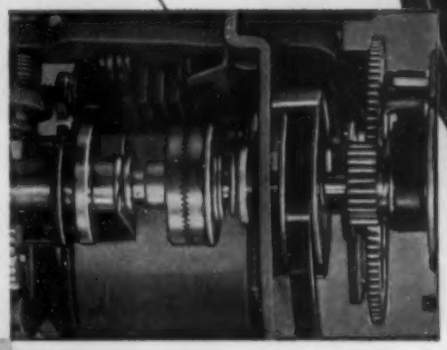
kipp

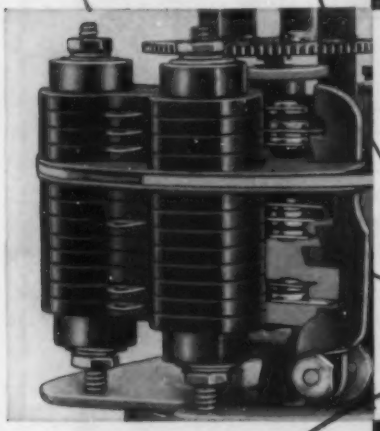
MADISON-KIPP CORPORATION
206 WAUBESA STREET • MADISON 10, WIS., U. S. A.

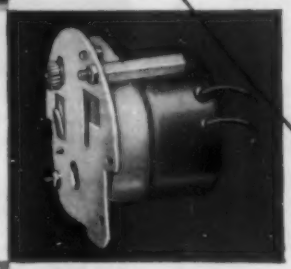
• Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools

NEW Cramer type 412 TIME DELAY RELAY

from face to terminal block







NEW—Repeat Accuracy within ± ¼ of 1% of full scale (30 sec. and longer ranges); ± ½ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

NEW O-Ring Retainer permits quick removal of bakelite housing, exposing entire timer mechanism.

Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.

Cramer TIMING DEVICES

The R. W. CRAMER CO., Inc.

SPECIALISTS IN TIME CONTROL

BOX 7, CENTERBROOK, CONNECTICUT

HCRD

Wagner®
ELECTRIC MOTORS
... the choice of leaders in industry

New NEMA Frames
Standard and Explosion-proof

Type EP
215 Frame

Wagner Totally-Enclosed Fan-Cooled Motors

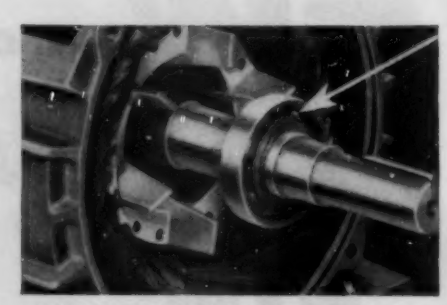
cut maintenance time and costs

Check the features of the new *Wagner Type EP Totally Enclosed Motor.* They spell the difference between needless expenditures in maintenance time and costs . . . and a definite savings in motor upkeep and repairs. You'll find that for general industrial use where dust, dirt, filings, abrasives, steel chips or moisture are present, the Wagner Type EP Motor gives steady, troublefree performance and longer service life.

Wagner Type JP Explosion-Proof Motor . . . has the same quality construction as the Type EP — plus added features which make it completely safe to operate where explosive dust, gases or vapors are present.

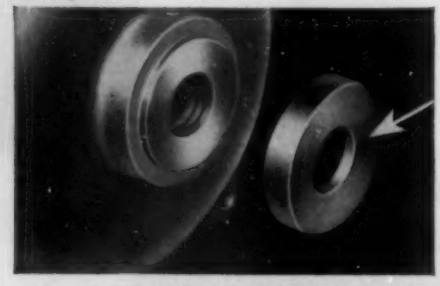
Both Type EP and JP Wagner motors are available in ratings up to 250 horsepower. For complete information, just call the nearest of our 32 branch offices, or write for Bulletin MU-203.

Wagner Electric Corporation
6406 Plymouth Ave., St. Louis 14, Mo.

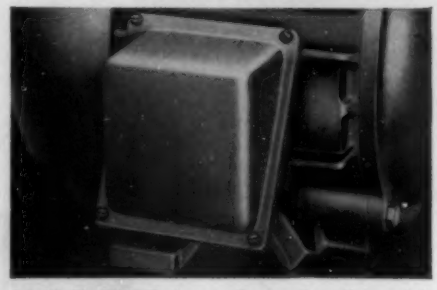


1 HEAVY-DUTY BALL BEARINGS—Highest quality bearings of more than ample capacity provide long, troublefree service.

2 BEARINGS CAN BE RE-LUBRICATED—Wagner motors can be re-lubricated when necessary to prolong bearing life.



3 BEARINGS STAY CLEAN—Both ends of these motors are equipped with running shaft seals, a machined collar mounted on the motor shaft.



4 EASY TO CONNECT—Large diagonally-split conduit box provides ample room for making connections. Leads are permanently identified.

5 NO GREASE LOSS—Bearing housings have effective seals to prevent escape of grease.

6 RIBBED FRAME—Ribs on the corrosion-resistant cast iron frames add mechanical strength and increase the surface area for more efficient cooling.

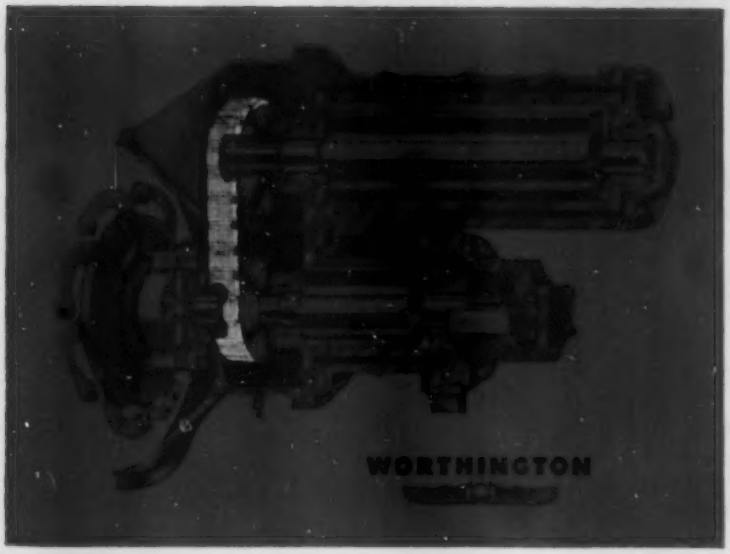
BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

M55-10

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

ON NEW WORTHINGTON ROTARY COMPRESSOR—

Morse HY-VO Chain provides smooth, quiet drive



Worthington *Blue Brute* Portable Compressor, showing cutaway view of compressor unit.

Morse Hy-Vo Drive in *Blue Brute* Rotary Compressor brings greater efficiency, smoother, quieter operation. Application shows way to product improvement in your field.

This new compressor packs plenty of power in a small space. Confined space applications such as this are possible with Morse HY-VO, because these compact drives transmit more power per inch of width at higher speeds, with great savings in weight and space over conventional methods.

Morse HY-VO Drives run smoother, quieter, cooler; they are easy to assemble and disassemble right on the job. The patented Morse HY-VO chain and sprocket engagement principle minimizes chordal action, gives you a more compact drive with quiet operation, even at velocities over a mile a minute. Transmitting up to 5000 hp in a single drive unit, HY-VO offers up to 50% longer service life, and a reduction in cost per operating hour by as much as 50%.

HY-VO runs at speeds up to 8500 fpm, making it possible to get the economies of using lighter weight, higher speed engines. HY-VO also cuts vibration to a minimum, runs with more than 99% efficiency.

Write for HY-VO Chain Catalog today!

These Morse HY-VO Chain advantages give real economy:

- √ Longer service life
- √ Easy to assemble, install, and service
- √ Speeds up to 8500 fpm
- √ Transmits up to 5000 hp
- √ Saves weight and space
- √ Less vibration, less heat

Look to Morse for Power Transmission

Investigate the complete line of Morse products, and utilize the services of Morse engineers, who can help you solve your problems involving: Roller Chain, Silent Chain, Sprockets, Clutches, Couplings, Torque Limiters.

MORSE CHAIN COMPANY
INDUSTRIAL SALES DIVISION
ITHACA, N.Y.

MORSE BW **CHAINS, CLUTCHES, AND COUPLINGS**

FOR POSITIVE, LOW-COST SPROCKET DRIVES...

TRY GENUINE BEAD CHAIN

Now successfully employed in radio and TV tuners, recorders, air conditioners, timing devices, etc. Designed for economical, positive gear trains or drives free of slippage and backlash.

VERSATILE BEAD CHAIN

has many other advantageous applications such as:

- part retainers
- remote control devices
- fan or ventilator pulls
- revolving displays

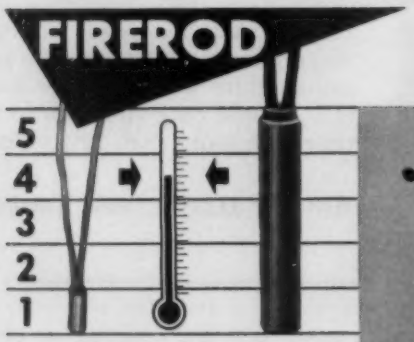
and many others

WRITE TODAY FOR CATALOG AND SPECIFICATION SHEETS

THE BEAD CHAIN MFG. CO.

92 Mountain Grove Street, Bridgeport, Conn.

WATLOW'S NEW



CARTRIDGE HEATING UNIT

...HOT NEWS in cartridge heating units

SAME HEAT in 1/5 the size!

- A NEW HIGH of 375 watts per sq. in. (500°F operating temp. with .005" fit in hole.)
- L-O-N-G-E-R cartridge life.
- LIGHTER WEIGHT and smaller size—for greater flexibility in installation and design application.

WRITE for Bulletin 355.

WATLOW ELECTRIC MFG. CO.

1392 Ferguson Avenue, St. Louis, Mo.

measures 4 x 5 x 10 in. and weighs 20 lb. Fischer & Porter Co., Hatboro 35, Pa.

For more information—
Circle 52, inside back cover

One-Position Weight Cell

A weight-sensitive cell which can be set for activation at any one predetermined load point is said to be built to withstand over 1 million cycles of operation. Fitted to a deflecting member, this entire assembly is hermetically sealed in a stainless steel case. No special instrumentation or readout equipment is required. The cell operates at 1 amp, 125 v, ac, and is currently available in ranges of 500 through 10,000 lb.

The total travel of the cell at the load point is approximately 0.005 in., and a steel stop in the cell prevents damage to the switch even under extreme overload. The new cell is suggested for use as an actuator for treadles where low loads must be ineffectual, as a safety indicator on crane hooks and drag lines, as a tripping device for automation at given load points. Control Cells Corp., Box 337, Boulder, Colo.

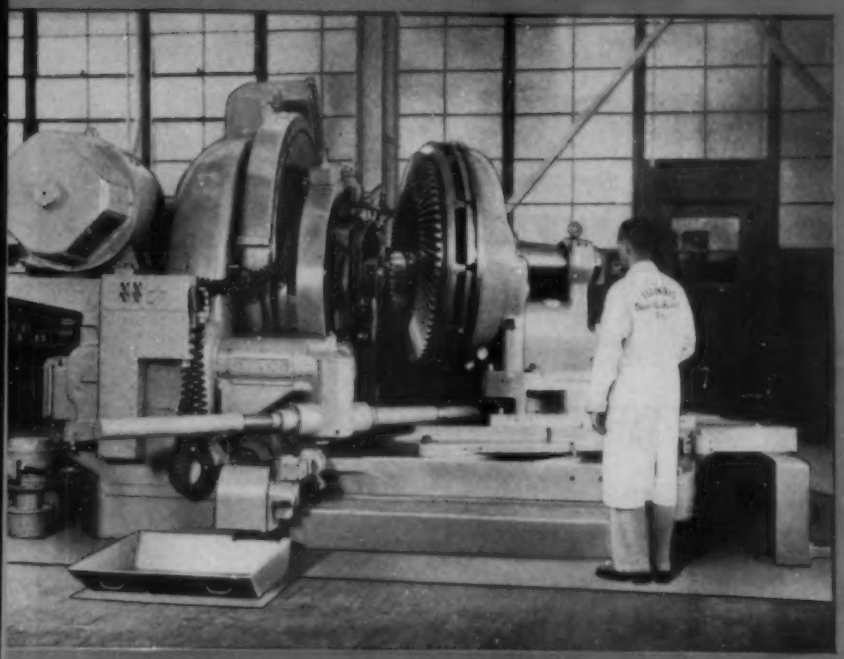
For more information—
Circle 53, inside back cover

Miniature Proximity Impulse Generator

The Model 50 A provides a self-generated output voltage proportional in amplitude and frequency to the velocity of magnetic material moving in proximity to the sensitive end of

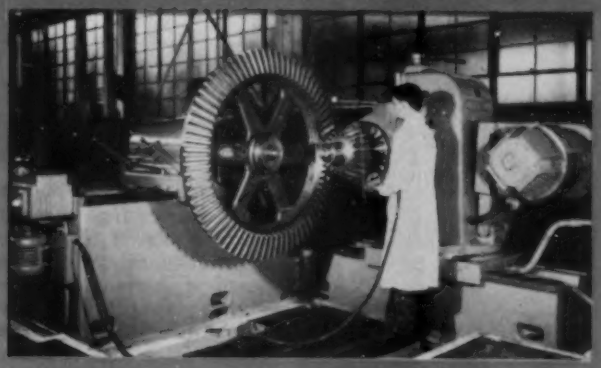
(Continued on page 254)

BIG SPIRAL BEVEL ZEROL BEVEL HYPOID GEARS

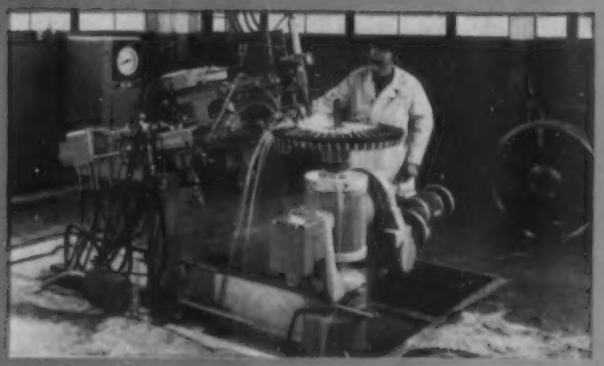


PRECISE GENERATION OF BIG BEVEL GEARS

This new No. 170 Spiral Bevel and Hypoid Gear Generator is the nucleus of the most modern and productive unit of large bevel gear generating machinery in the world. It generates spiral bevel, zerol bevel, and hypoid gears to 72" diameter, 2.875" tooth depth (.75 D.P.), 10" face, and 10" hypoid pinion offset above or below centers. The localized gear tooth bearing, an established necessity for today's heavily loaded gear drives, is precisely controlled to your specifications.



POWER TESTING—This new No. 61 Angular Hypoid Testing machine is the most advanced of its kind. Large spur, helical, herringbone or bevel gears are operated under load at any shaft angle, giving exact inspection of tooth contact under operating conditions. It will efficiently test gears up to 90" diameter and hypoid offsets to 10" above or below centers.



SURFACE HARDENING—This new No. 2 Flame Surface Hardening machine is closely controlled electronically to produce precise, uniformly distortion-free results—it's the all important climax to our large gear production facilities. Spur, helical, bevel and hypoid gears to 120" diameter, .75 D.P., and 18" face are surface hardened in this machine.

Visit our modern plants—see the finest equipped plants in the world—designed to serve you.

Look for this mark ILG ... the symbol on finer gears

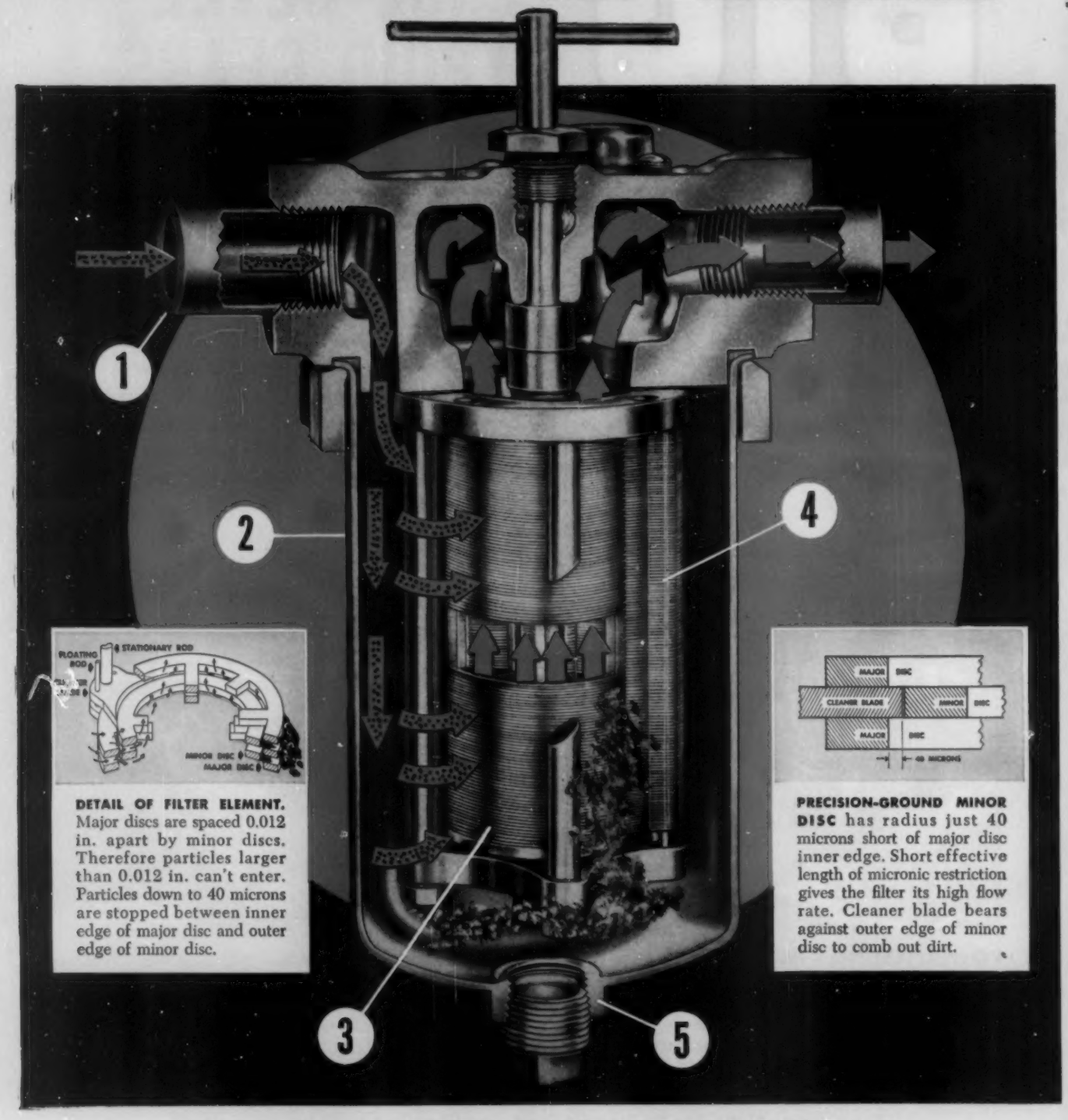
ILLINOIS GEARS Reg. U.S. Pat. Off.

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

New! CUNO 40-micron



DETAIL OF FILTER ELEMENT. Major discs are spaced 0.012 in. apart by minor discs. Therefore particles larger than 0.012 in. can't enter. Particles down to 40 microns are stopped between inner edge of major disc and outer edge of minor disc.

PRECISION-GROUND MINOR DISC has radius just 40 microns short of major disc inner edge. Short effective length of micronic restriction gives the filter its high flow rate. Cleaner blade bears against outer edge of minor disc to comb out dirt.

CUTAWAY of new SUPER Auto-Klean. Dirty liquid enters inlet (1) at left, fills housing (2) and flows through metal-edge filter (3) of stacked major and minor discs. Trapped dirt is combed out by cleaner blades (4) when discs are rotated and is removed through drain (5). Clean liquid rises through center of filter element, leaves at right.

self-cleaning filter!

The SUPER Auto-Klean for lube, hydraulic fluid, coolant, fuel and other liquids

. . . and you can clean this filter by simply turning the handle!

Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, compact, micronic filtration at high flow rates and eliminates the need for replacement cartridges. On machine tools and industrial machinery, SUPER Auto-Klean gives micronic filtration of lubricating oil, hydraulic fluids, coolants, fuels and other liquids. Here's what it offers:

1. Full-flow micronic filtering with a self-cleaning filter. Filter can be cleaned continuously with motor drive or intermittently by manually turning handle.

2. Eliminates cartridge changes. Ends operating costs if you've been using cartridge filters.

3. No pressure drop build-up. An 8-in. long, 2⅝-in. diameter cartridge handles 30 gpm of oil of 200 SSU viscosity with only 3 psi pressure drop—up to 75% more with slightly higher pressure drop.

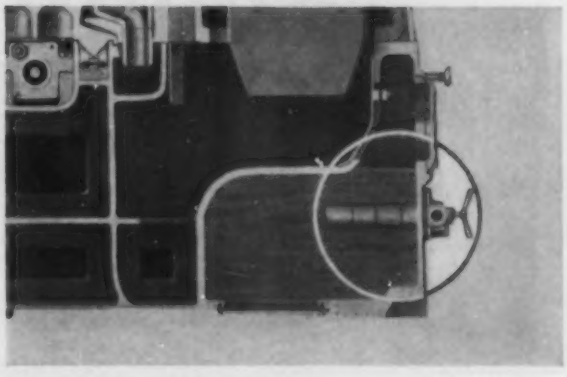
4. Positive protection against particles larger than 40 microns (actually 0.0015 in.). Filter can't rupture or channel.

5. Much smaller than replaceable-cartridge-type filters of equal capacity. It saves with lower initial costs, lower installation costs, requires less space than cartridge units. You get high capacity in a small package.

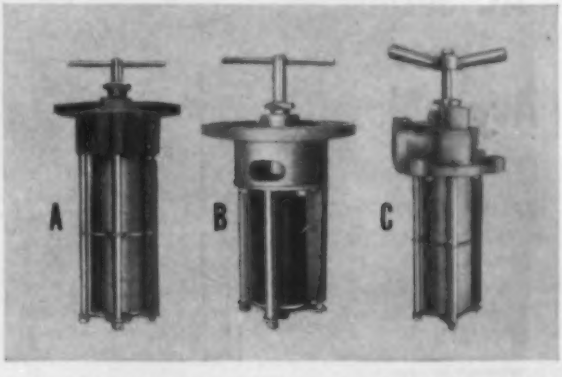
6. No duplex units needed. Handles full flow all the time with no interruptions for cleaning.

7. SUPER Auto-Klean fits existing Auto-Klean housings. You can easily replace most 2¼-in. diameter cartridges with SUPER Auto-Klean for finer filtration.

Send coupon for complete information on the new SUPER Auto-Klean filter, for your new designs or existing equipment. Cuno Engineering Corporation, 20-11 South Vine Street, Meriden, Conn. 5.6



WILL IT FIT? Here's how one designer answered that question. Filter *(circled)* mounts horizontally in side wall of hydraulic fluid reservoir in this surface grinder.



FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best in filtration. Flange mounting with external outlet *(C above)* and line-type *(cutaway on facing page)* are just two of many other possibilities.

MAIL COUPON FOR COMPLETE INFORMATION

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids from More Kinds of Fluids

AUTO-KLEAN (disc-type) • **MICRO-KLEAN** (fibre cartridge)
FLO-KLEAN (wire-wound) • **PORO-KLEAN** (porous metal)

CUNO ENGINEERING CORPORATION
20-11 South Vine Street
Meriden, Connecticut

Please send me full data on the NEW Cuno SUPER Auto-Klean filter.

Name_____

Firm_____

Position_____

Address_____

City_____ Zone_____ State_____

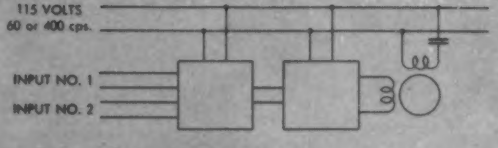
NEW!

MINIATURE

SERVO

Magnetic Amplifiers

Three New AC Servo Types Available..



STANDARDIZED SERVO SYSTEMS AND OTHER STANDARD TYPES FOR AUTOMATIC CONTROL —

In addition to new lines illustrated, many standard and higher power magnetic amplifiers are available for applications involving automatic control.

CUSTOM DESIGNS FOR SPECIAL REQUIREMENTS

— we design and engineer complete servo or automatic control systems

● **MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS**
Supply: 115 volt 400 cps.
Power output: 3.5, 6, 10, 18 watts
Sensitivity: 1 volt AC
Response Time: .03 sec.
Lowest Cost — Smallest Size
For further information request Form S493

● **MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER**
Supply: 115 volt 400 cps.
Power output: 5, 10, 15, 20 watts
Sensitivity: .1 volt AC
Response Time: .008 to .1 sec.
Highest performance — All magnetic
For further information request Form S496

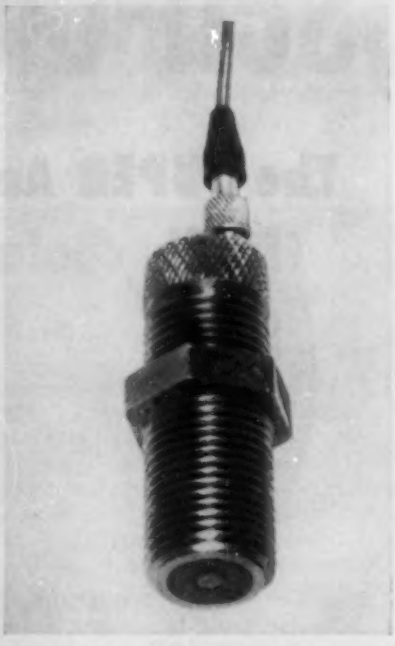
● **TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER**
Supply: 115 volt 400 or 60 cps.
Power output: 2, 5, 10, 15, 20 watts
Sensitivity: .08 volt AC into 10,000 ohms
Response Time: .01 sec.
Fast response at high gain
For further information request Form S499 (400 cps.); Form S497 (60 cps.)

*TRADE NAME

AFFILIATE OF THE GENERAL CERAMICS CORPORATION

MAGNETIC AMPLIFIERS • INC
Telephone: CYpress 2-6610
632 TINTON AVE., NEW YORK 55, N. Y.

Electric Power, Control



the pick-up. The device, when used with commercially available electronic counters, provides an accurate means of measuring, counting or detecting movement, vibration or speed of a shaft or other part.

Stock units are encapsulated in a stainless steel housing, which is $\frac{3}{8}$ x $1\frac{3}{4}$ in. long. Minatron Corp., 10 Clivedon Pl., Belle Mead 10, N. J.

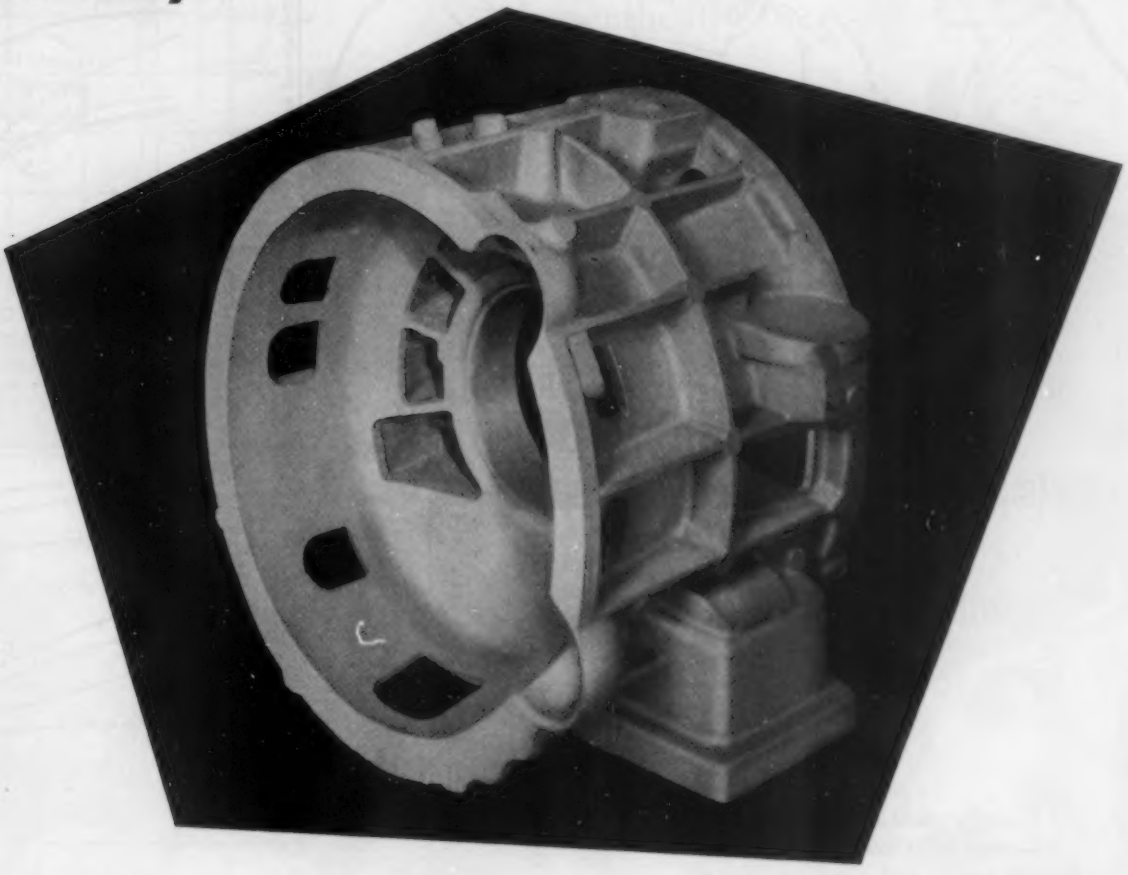
For more information— Circle 54, inside back cover

Shaft-Position Analog-Digital Converter

This converter translates the position of an input shaft into the Gray binary-digital code. The distinguishing feature of the Gray code is that only one binary code position changes (from 0 to 1, or vice versa) as the equivalent numerical value changes by one unit. The eight rings of the converter's disc contain a total of 256

(Continued on page 258)

this is the aluminum industrial converter housing they said couldn't be cast this way!



Every company at some time accomplishes a difficult task that brings real satisfaction to everyone. Such is the case with the 65 pound semi-permanent mold casting shown above made for a division of an automotive major. One of our respected competitors said, "It can't be done that way." The casting buyer said, "It's got to be done." We did it, delivered it ahead of schedule, and the costs were right. Everyone was happy about the job.

Centr-O-Cast manufactures a complete range of aluminum castings in the permanent mold, semi-permanent, centrifugal, and centrifuge fields ranging in weights from 2 ounces to 65 pounds. All alloys are used, either regular or heat treated. Operating at the rate of 750,000 pounds of finished castings per month Centr-O-Cast ranks as one of the larger permanent and centrifugal casting foundries in the country.

Next time your drawings call for aluminum we would like to help. A card will bring an illustrated brochure, or, if you prefer, a personal call by our casting consultant.

Small permanent mold aluminum castings which proved that quality need not be expensive.

centr-o-cast

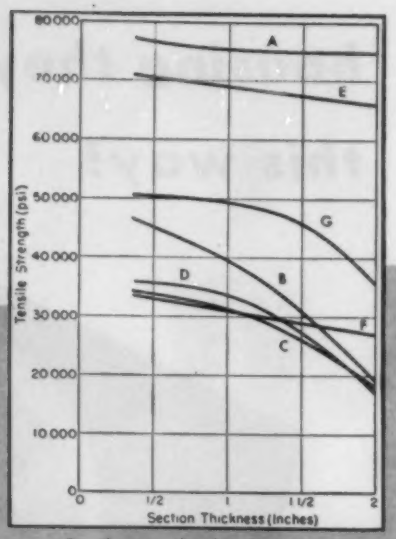
CENTR-O-CAST AND ENGINEERING COMPANY

45 St. Jean Avenue, Detroit 14, Michigan

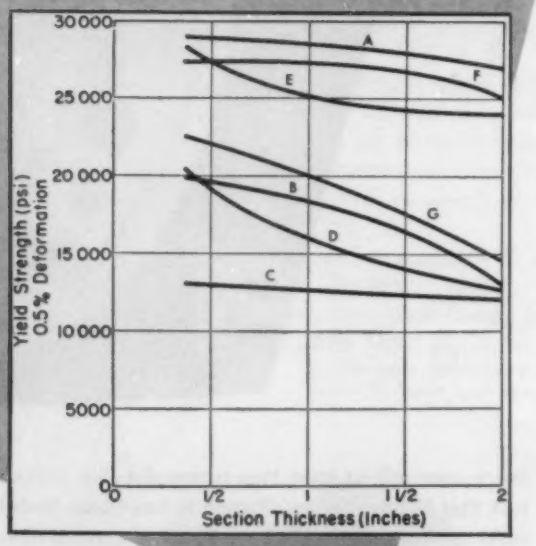
Here's proof....

that you can use lighter sections, have greater strength, improve your product, save money

with AMPCO* Metal



Tensile strengths of various non-ferrous metals vs. section thickness



Yield strengths of various non-ferrous metals vs. section thickness

Examine these charts carefully — they tell a story that can save you money and put extra life and dependability into your product.

Look, for instance, how other non-ferrous metals show a sharp decrease in mechanical values as casting cross-sections increase. Ampco remains practically constant — you require less metal.

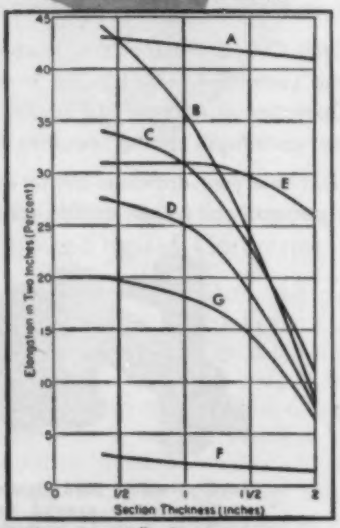
Note Ampco's unusually high tensile and yield strengths compared with conventional bronzes — you use lighter sections to do a better job. And Ampco Metal weighs 10 to 15 percent less than other bronzes — so you can make important weight reductions.

Fact is, Ampco Metal's high strength-to-weight ratios can mean real savings for you — savings in material and money. Consult your nearby Ampco field engineer for full information or write us.

CHART REFERENCE

- A. Ampco Metal
- B. Tin Bronze (88-8-4)
- C. Red Brass
- D. Tin Bronze (85-5-5-5)
- E. Manganese Bronze
- F. Aluminum Alloy
- G. Silicon Bronze

Charts courtesy Materials & Methods and Westinghouse Electric Corp.



Elongations (2") of various non-ferrous metals vs. section thickness

AMPCO

Sole Producer of Genuine Ampco Metal

AMPCO METAL, INC.

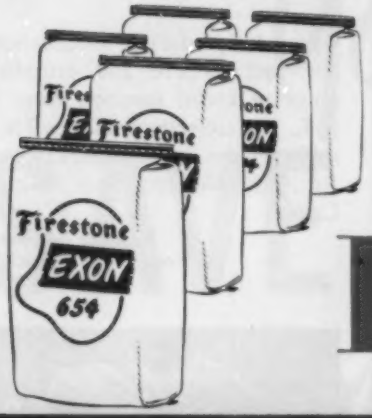
Dept. PE-11, Milwaukee 46, Wisconsin

West Coast Plant: BURBANK, CALIFORNIA

*Reg U S Pat Off

9-43

EXON: each resin engineered for a specific problem



EXON 654

specifically for

Plastisols

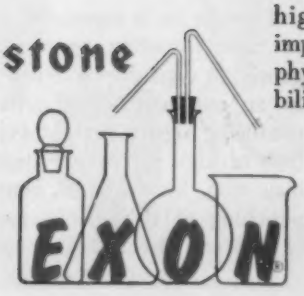
Waste no more time on grinding —EXON 654 never needs it! Even when simple stirring equipment is used, Firestone's plastisol resin readily disperses in plasticizer.

It's an extremely fine powder with high molecular weight, created to impart excellent heat and light stability, physical toughness and chemical stability to your products.

Slush molders particularly will appreciate the exceptional viscosity, stability and flow properties of pastes formulated from EXON 654. These pastes are unsurpassed for processing ease. They gell quickly. And they always coat the mold smoothly and evenly.

Whatever your particular problem, you're likely to find the specific remedy among Firestone's many Exon resins.

Firestone



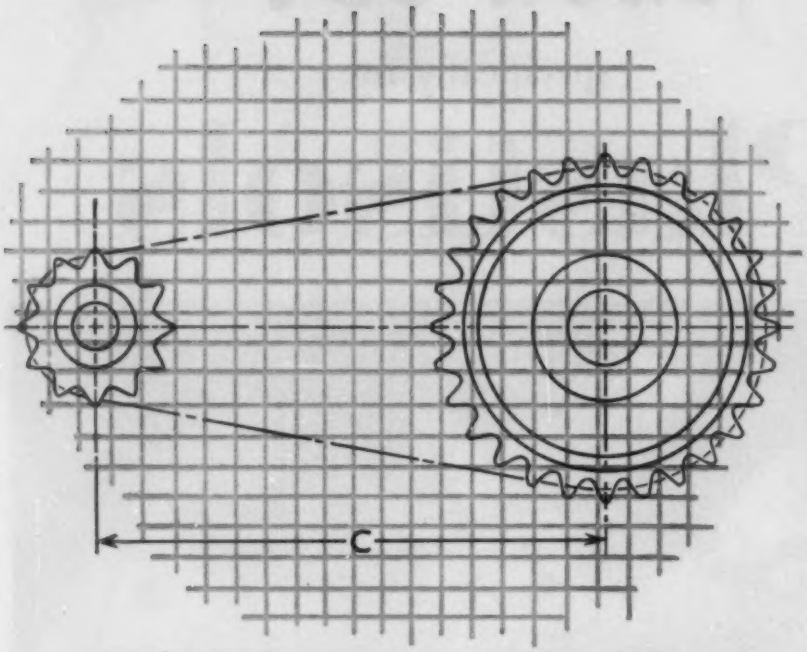
For complete information or technical service on the entire line of EXON *resins, call or write today.*

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. 6W

DIVISION OF FIRESTONE TIRE & RUBBER CO.

Designers! Determine this Chain Length



GIVEN:

Teeth in small sprocket	17
Teeth in large sprocket	78
Center Distance	36″
Pitch of Chain	1″

To find — Chain length in inches. *(Answer below)*

Answer: 56.354 inches

Acme Chains latest 76 page catalog brims with chain data. Filled with information on the correct and most efficient use of roller chain, cable chain and all types of sprockets. Among many other things it gives you the correct formula for computing proper chain lengths.

***FREE** to Engineers and Designers. Write Dept. 1A, ACME CHAIN CORP., Holyoke, Mass.*

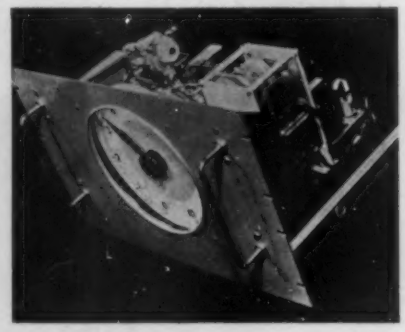
Write or Call JE 2-9458 for immediate chain delivery or free engineering service.

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

Electric Power, Control

segments, producing a resolution of one part in 256 and providing a range of coded numbers from 1 to 255. The converter measures 3½ x 1⅝ in. long) and weighs 8 oz. Librascope, Inc., 808 Western Ave., Glendale, Calif.

For more information— Circle 55, inside back cover



Voltage-To-Digits Converter

This device converts any process variable that can be represented by an electrical signal into a form suitable for directly operating electric typewriters, digital printers, tape or card punches, lamp bank or for initiating process control. As many as five readings a second with accuracy of ±0.15 per cent of full scale on all readings is said to be possible.

Designed for panel mounting in a standard 19-in. relay rack, input signals of d-c voltages—representing temperature, pressure, flow, acidity or any other process variable—are amplified by a d-c chopper type amplifier and then fed to a null-balance potentiometer. Fischer & Porter Co., Hatboro 35, Pa.

For more information— Circle 56, inside back cover

Binary Coded Digital Converter

This device is especially applicable to data recording systems, control panels, or digit display units, plotting by an automatic coordinate plotter, producing signals for automatic controls of high precision equipment. It may also be used to control the punching of IBM cards, paper tape or printer. The unit is a specialized

(Continued on page 262

You can SAVE UP TO 40% —on Controls

There *is* a better way to specify and buy the temperature, pressure, vacuum, liquid level and humidity controls that go into your equipment. A unique plan offered by Honeywell puts an end to hit-or-miss buying . . . reduces inventories . . . simplifies purchasing . . . and can save you up to 40 per cent in total controls costs.

All these advantages are yours, with the—

★ HONEYWELL CONTROLS PURCHASE PLAN

It's economical—because you buy on planned schedules that give you the benefit of most advantageous prices.

It's convenient—because you receive shipments at a rate which is geared to your own usage. Consolidation of purchases simplifies your stocking problems, too.

It's simple—gives you the advantages of a single responsibility. Whatever your application, you'll find the more than 7000 different Honeywell controls include the type you require.

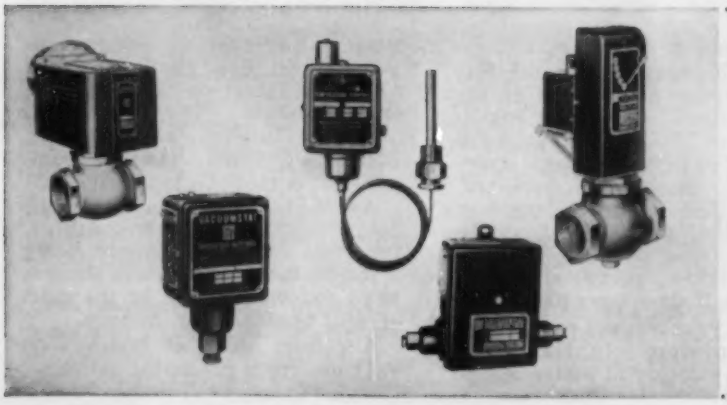
You'll profit, too, by the high quality and nation-wide service that represent exclusive plus values in every Honeywell control.

We'll be glad to give full details; just fill in and return the coupon.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario. *Also manufacturers of a complete line of precision measuring, recording and controlling instruments.*

MINNEAPOLIS **Honeywell**

First in Controls



Industrial Division
Minneapolis-Honeywell Regulator Co.
Wayne and Windrim Aves., Philadelphia 44, Pa.

☐ Please send me your catalog on Honeywell Controls.

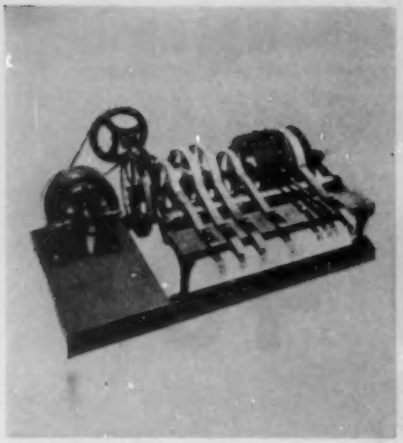
☐ I'd like a Honeywell sales engineer to discuss how the Honeywell Controls Purchase Plan can be applied to my control purchases.

*Name*_____

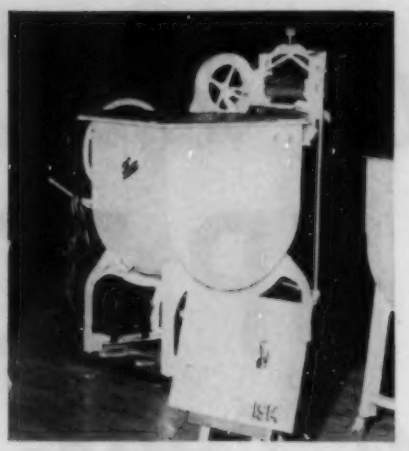
*Title*_____

*Company*_____

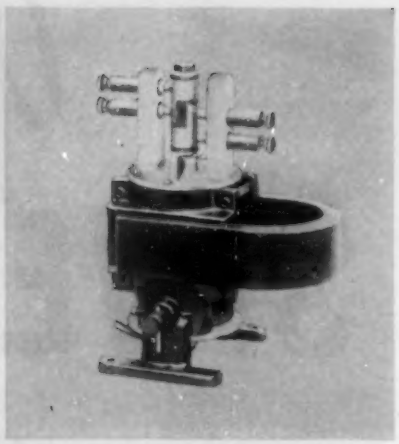
*Address*_____



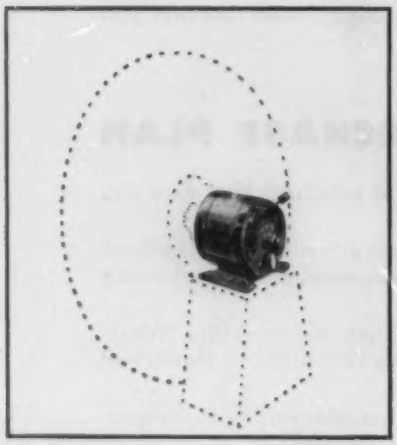
1905 . . Einstein had just introduced the theory of relativity. The Bodines received their first orders . . one from Reynolds-Dull Flasher Co. to run this sign flasher.



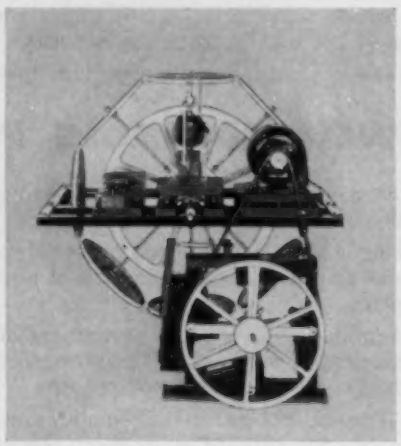
In 1906 the forward pass became a part of football. And housewives were thrilled with this handy device called the washing machine. A Bodine motor operated it.



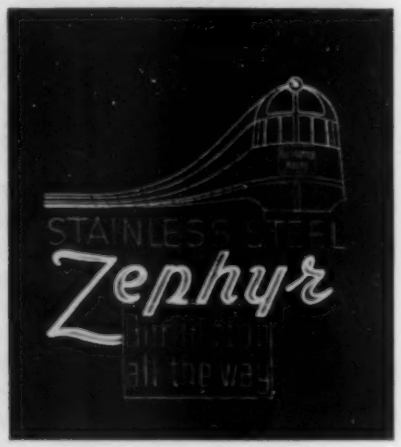
Jim Jeffries came out of retirement, fought Jack Johnson and lost. The telephone was popular, and Bodine motors were used to power this ringing machine. It was 1910.



Ford unveiled the model "A". Inventors experimented with something called TV . . and they used special Bodine motors to drive their scanning discs. The year: 1928.



In 1930 Marilyn Miller starred in "Smiles". And to America's eating spots came the ferris wheel-like turntables of the juke box . . often operated with a Bodine motor.



A huge electric sign, using a Bodine motor, advertised a well known railroad in 1933 . . the same year Gen. Balbo led a fleet of 24 flying boats from Rome to Chicago.

Industry's Use of Electric Motors, 1905-1955, Traced by Bodine

Pictures of old Thor washing machines, 1910 telephone ringing machines, juke boxes from the 1920's, and dozens of other interesting items came to light recently as Bodine Electric Co., Chicago manufacturer of fractional horsepower electric motors, dug deep into its files of yesteryear for examples of early motor applications. Purpose of the search was the celebration of the company's 50th anniversary.

Late in 1954, Bodine called in special writers . . gave them the job of gathering facts and figures on the company's history.

Research revealed that the Bodine story was not without an interesting tinge of Horatio Alger. There were the very first days when the embryo company operated from the Bodine brothers' bedroom. Then came the big day . . when the company formally came into being with a capitalization of $1,050.00 . . just about all the money the Bodine boys had.

The first year was not easy . . only four motors were sold. Had it not been for a number of motor maintenance contracts, the young company might have failed. Came 1906, and business was better . . sales exceeded 160, including a "volume" order . . for ten motors. Succeeding years, saw the company grow larger and larger.

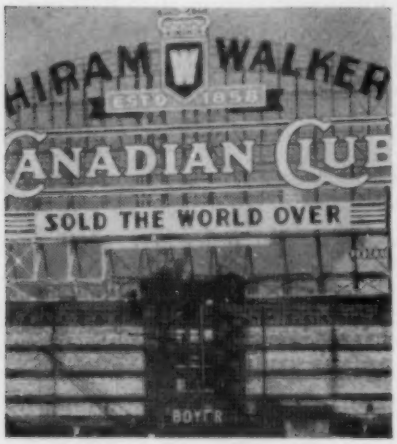
As might be expected, Bodine outgrew its quarters frequently . . the most recent expansions being a second factory erected in the late 40's . . followed in 1955 by the start of still another new factory.

A picture story of Bodine's 50 year growth is presented above.

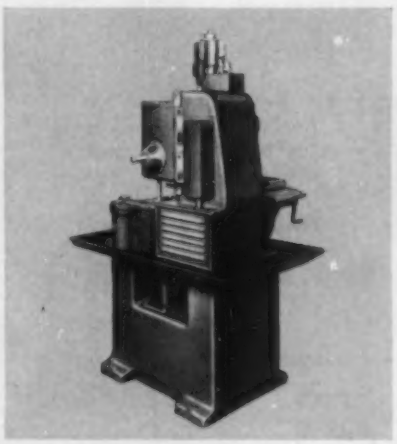
The new model 1915 cars had steering wheels on the left. The public was becoming conscious of proper dental care . . and dentists used drills powered with Bodine motors.

In 1919, well brought up ladies still frowned on the use of rouge, but current ads showed how pleased they were with the Multigraph . . powered with a Bodine motor.

New York to Los Angeles airmail started in 1924! America boomed, banks were busy . . many used check cancelling machines like this . . powered with Bodine motors.



The Japs sank the gunboat Panay in 1937, the dirigible Hindenburg exploded, and on Chicago's lakefront, Bodine motors helped operate this sign . . the world's largest.



In May 1940, Holland, Belgium, and France fell to Germany. In America, machine tools were in demand . . machine tools like this "Cincinnati" powered by a Bodine motor.

1941 . . Pearl Harbor! In South Bend at the University of Notre Dame, a strange looking machine was smashing atoms. Bodine motors helped operate its controls.

Gen. Eisenhower invaded Normandy in 1944. Armies used almost as much paper as ammunition . . and Ditto machines, like this one, were powered with Bodine motors.

Joe Louis smashed Jersey Joe Walcott in 1948 . . then retired. Others saw stars via the new 200" Mt. Palomar telescope . . operated by some 100 Bodine motors.

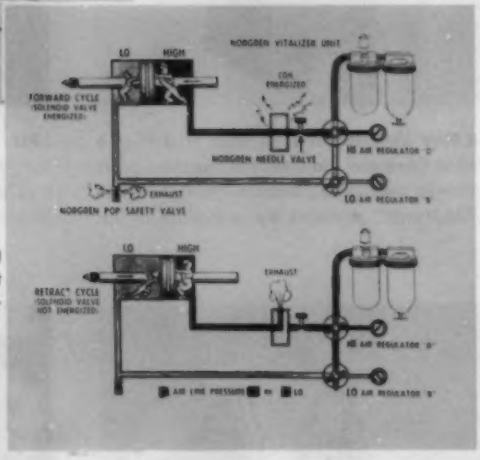
Brooklyn recorded its first World Series championship. And many radio stations recorded with this Berlant Recorder . . powered with a Bodine motor. Yes, it's 1955!

Norgren solves design problem for DUMORE with MICRO-FOG lubrication

The recent development of the Dumore Series 24 Automatic Drill Unit presented a difficult lubrication problem: *How to lubricate several small air cylinders requiring air at considerably less than 1 cfm.*

Only Norgren offered a solution... a special Micro-Fog Lubricator that would provide thorough lubrication at this extremely low air flow. Details of the Norgren Micro-Fog System are shown in the drawing below.

A Dumore Radial Drilling Application with three Series 24 Drill Units each equipped with a Norgren Micro-Fog Vitalizer Unit (Filter-Lubricator), a Norgren Pop Safety Valve and a Norgren Needle Valve.



Schematic Drawing showing air lines from Norgren Vitalizer Unit to Air Cylinder

You, too, can take advantage of this specialized and extensive experience in Aerosol Lubrication... just call NORGREN

THE PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 27 YEARS

For complete details on this Norgren Micro-Fog application, write for Norgren Blueprint No. 121, or phone the Norgren representative listed in your telephone directory classified section under Norgren Pneumatic Products.

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

Electri Power, Control

analog-to-digital converter which uses a pattern design to provide a decimal form readout, but coded in binary notation.

The basic element of the converter is a commutator-type disc consisting of concentric rings of alternately conductive or non-conductive segments corresponding to the 1-2-4-8 binary code. The disc, which is geared to the input shaft, contains 200 segments, producing coded numbers from 000 to 199. The converter is non-sensitive to magnetism and is operable at temperatures from —50 C to 85 C. All units have a phenolic base with rhodium-plated commutator for corrosion and wear resistance. The new converter is commercially available in single, double and triple disc models in ranges to 200, 2000, 3600, 20,000 and 36,000 units. Librascope, Inc., 808 Western Ave., Glendale, Calif.

For more information— Circle 57, inside back cover

Sub-Miniature Potentiometers

These wire-wound precision potentiometers are ½ in., dia and are being made in special ganged control units. Available in the resistance range 200 to 100,000 ohm, the large number of turns of fine resistance wire in the element and the precision accuracy with which they are spaced is said to

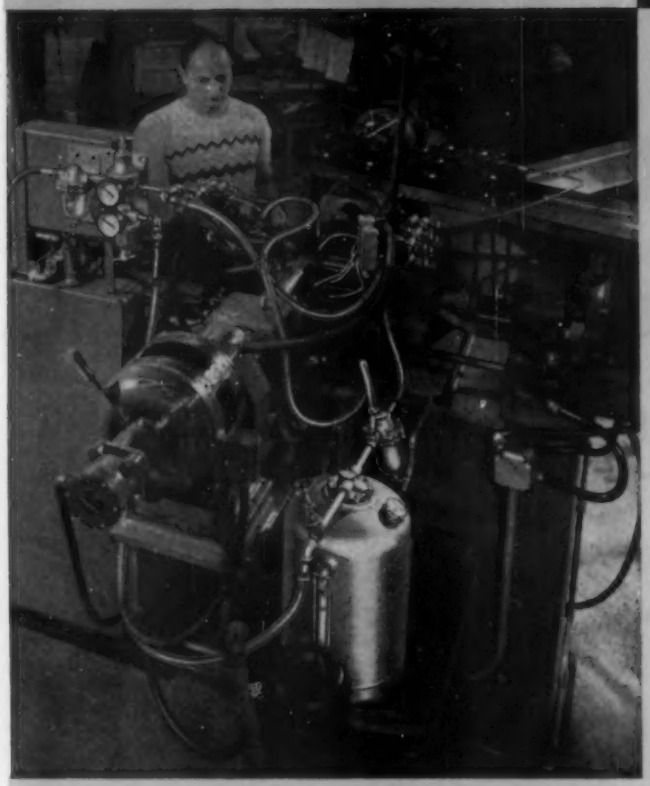
(Continued on page 266)

HOW *Norgren* **Spray-Lube** *System* **CAN SIMPLIFY DESIGN OF MACHINE TOOLS**

and provide many profitable advantages for users

FOR EXAMPLE

A-P CONTROLS CORP.



installed Spray-Lube on tapping machine...

- **increased tap life**
- **increased tapping speed**
- **eliminated problem of chips plugging coolant lines**
- **eliminated messy condition of splashing coolant**

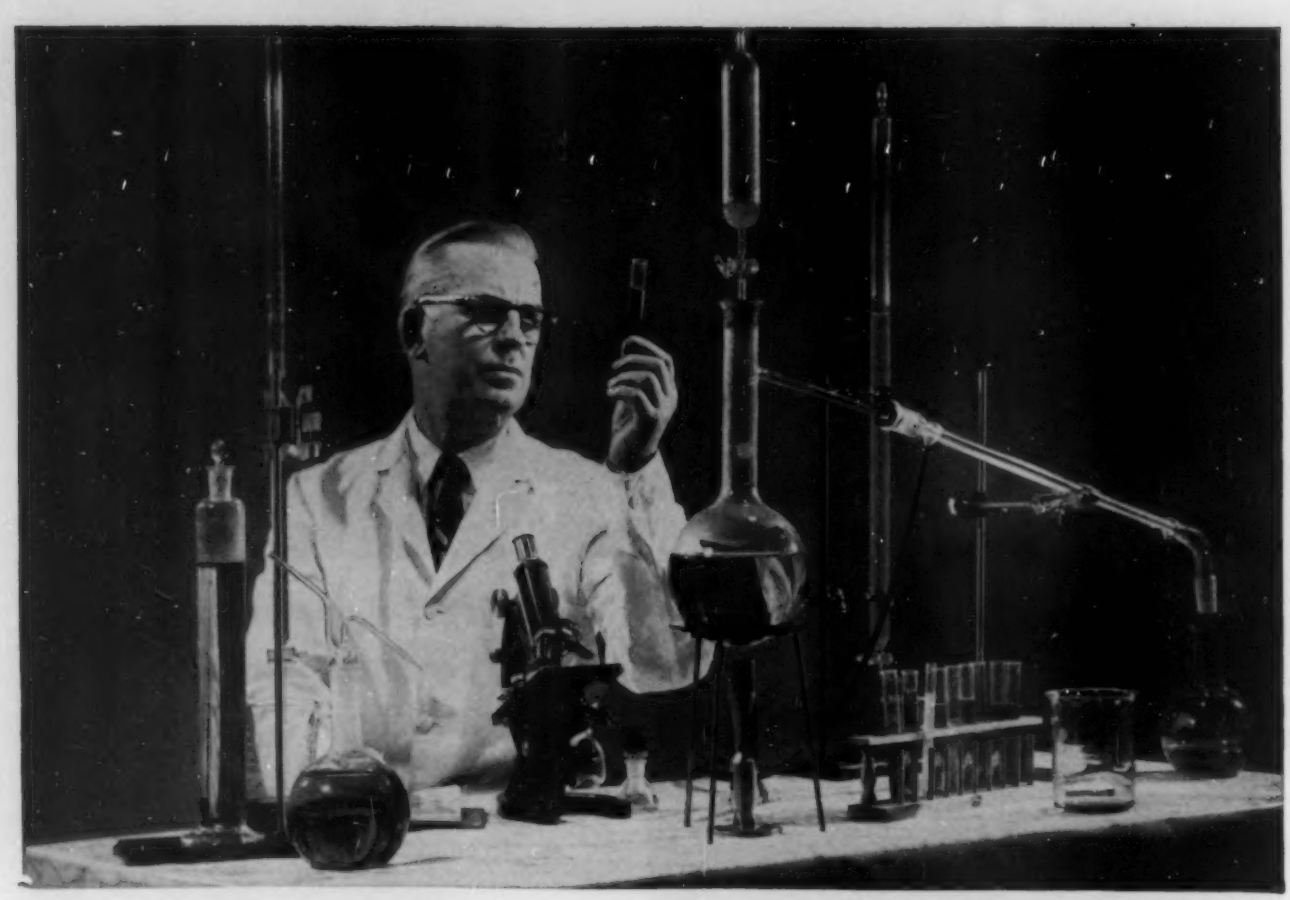
A-P adds 3 more
Since this installation A-P Controls has added Spray-Lube to three other machines.

Machine taps 12 holes of various sizes simultaneously. Norgren Spray-Lube System includes 5 gal. tank, 12 mixing valves and spray nozzles. Air and liquid line pressures are 42 psi and 44 psi, respectively.

FOR COMPLETE DETAILS write for Norgren Blueprint No. SL-4

OIL FOG LUBRICATORS • PRESSURE REGULATORS
AIR FILTERS • VALVES • HOSE ASSEMBLIES

C. A. *Norgren* CO.
3428 So. Elati, Englewood, Colo.



Bonding rubber to nylon is one of PHOENIX' specialties

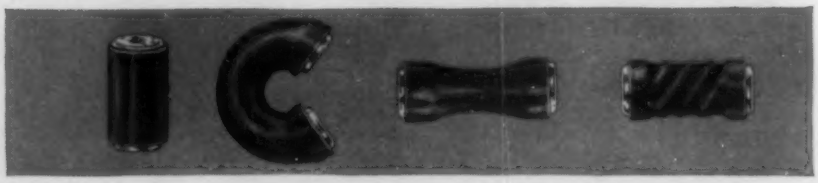
We are unusually successful at bonding natural and synthetic rubber to nylon. For example, with the flexible coupling shown below, the rubber will actually rupture before bond failure.

When you work with PHOENIX you have twenty years' experience in developmental work at your disposal. Quality control is of the utmost importance at PHOENIX. Modern laboratory facilities and exacting production control methods assure the closest of tolerances.

It is PHOENIX' practice to work in strictest confidence with our customers. Whatever rubber molding problems you may have, call on us. We are here to serve you.

Please address all inquiries to Rubber Products Division.

PUTTING THIS FLEXIBLE RUBBER-NYLON COUPLING THROUGH THE PACES. TESTING ITS "BEND," TENSILE STRENGTH AND TORQUE.



PHOENIX should be your source for custom rubber molding

PHOENIX MANUFACTURING COMPANY

RUBBER PRODUCTS DIVISION — JOLIET, ILLINOIS

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

MODERN INDUSTRY MOVES WITH HYDRAULIC POWER

delivered through

Eastman

HYDRAULIC HOSE ASSEMBLIES

EASTMAN — *first in the field* of Hydraulic Hose Assemblies—has had the privilege of *pioneering* in many original applications of hydraulic power — on equipment made by many of America's leading manufacturers — as shown in action in the industries, above.

Modern industry not only moves *hydraulically*, but with increased efficiency and economy—with improved production and performance . . . the kind of performance that improves your competitive position in your field.

If you have a power transmission problem, consult with Eastman Engineers. For improved performance due to many original exclusive Eastman designs . . . for quality of material and workmanship—always specify Eastman Hydraulic Hose Assemblies.

Eastman
first in the field
MANUFACTURING COMPANY
Dept. PE-11, Manitowoc, Wis.

FREE

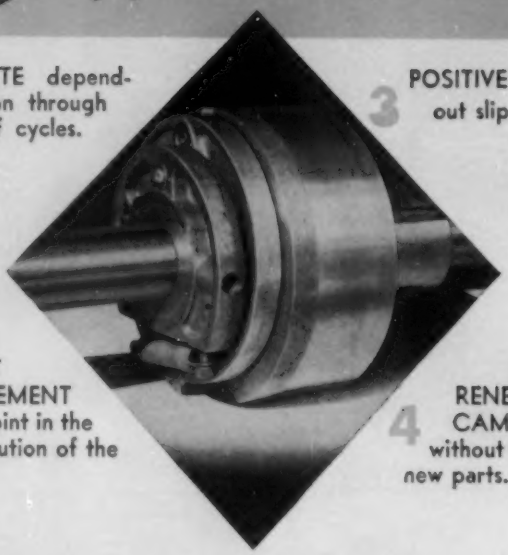
WRITE for free Catalog 101 on Eastman Hose Assemblies.

HILLIARD CLUTCHES FOR POWER CONTROL DESIGNS

HILLIARD
Single Revolution CLUTCH

1 ACCURATE dependable action through millions of cycles.

3 POSITIVE motion without slip or lag.



2 INSTANT ENGAGEMENT at any point in the the revolution of the driver.

4 RENEWABLE CAM SURFACES without machining or new parts.

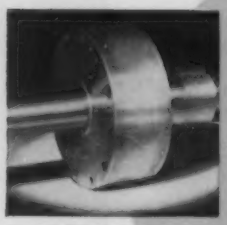
The Hilliard Single Revolution Clutch *is automation* because it provides precise accurate intermittent motion automatically. Control can be electrical or mechanical.

The use of Hilliard Single Revolution Clutches has improved the operation of tube straightening and cut-off machines—shears—conveyors—riveting and fastening units—case loaders—bottle unscramblers—weighing and packaging—indexing and feeding—marking—punching—textile and business machines—radar apparatus—proportionate pumps—and many other types of mechanisms.

WRITE TODAY FOR BULLETIN 239 WITH COMPLETE INFORMATION.

• OTHER HILLIARD CLUTCHES •

CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet or backstop action. Ask for Bulletin 231.

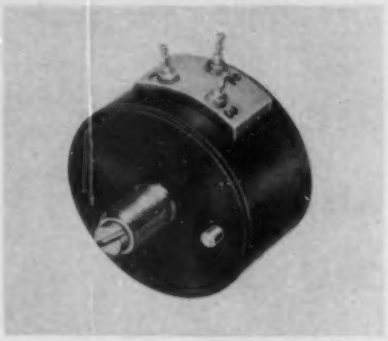
SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

THE HILLIARD CORPORATION
MANUFACTURING CLUTCHES FOR OVER 50 YEARS
101 W. FOURTH ST. ELMIRA, N. Y.
IN CANADA: UPTON • BRADEEN • JAMES, LTD.

give standard accuracy of linear units of ±0.3 per cent independent linearity.

Standard torque is 0.035 oz-in. at 20 C. Ace Electronics Associates, 125 Rogers Ave., Somerville 44, Mass.

**For more information—
Circle 58, inside back cover**



Intermediate Size Potentiometers

Anodized aluminum housings 1⅝ in. dia are machined from solid aluminum for optimum linearity and ganging dimensions. Multiple ganged units can be electrically phased independently without disassembly. Precious metal contacts are used exclusively, including a three-wiper contact brush. All single and ganged assemblies are completely enclosed by permanent dustcovers. Both threaded bushing and servo-mounting types are available. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

**For more information—
Circle 59, inside back cover**

Stepless Temperature Control

This controller modulates the power input to an electrical load so that heat input is only equal to heat losses. This is accomplished without the use of contactors as used with conventional "off-on" systems. The unit will vary power input to load between 3 and 90 per cent automatically, according to demand. Units have been made from 300 va to 110 kva single or three-phase and are available in higher ratings.

One unit can be used for several different loads and on either 115 or

(Continued on page 270)

Short cuts speed printed-circuit design at Brush Electronics Co.

"3-day job"...done in 3 hours

Brush Electronics Co., a Division of Clevite Corp., Cleveland, Ohio, finds countless uses for photographic materials and techniques in designing more than 700 products.

Take the draftsman working on that printed-circuit diagram, for example. The original practice was to draw such circuits in ink on heavy Bristol board.

Now, the job is done in a fraction of the time by positioning precut circles and lines, with adhesive backing, on a form. This is reproduced on Kodagraph Autopositive Film, a positive copy being obtained directly without a negative step. This reproduction—with dense black photographic lines on a translucent base—is sent to the vendor who makes the printed circuits.

Brush has also found that duplicate tracings, made quickly and economically on roomlight-handling Kodagraph Autopositive Paper or Film, are the key to further savings when drawings must be revised, or vendor prints reproduced. Such duplicates are continually being used in place of originals for reference and print making . . . are protection against possible loss or unavailability of the originals.

And Brush further streamlines drafting and engineering activities with the help of other Kodak materials—uses Kodagraph Contact Fine-Line Paper for revising and combining drawings, and making high-quality offset plates . . . uses Kodalith Film in preparing "pictorial" assembly drawings, reduced-size drawings, handbook pages, graphs. *Sometimes four or five materials are used on one job, for top-quality results and savings at every step.*

To learn the ways Kodagraph and other Kodak reproduction materials can serve you, just mail coupon below, or get in touch with your local blueprinter.

Kodagraph Reproduction Materials

New booklet is jam-packed with valuable tips on saving drafting time, protecting drawings, getting better prints.

----------MAIL COUPON FOR FREE BOOKLET----------

15

EASTMAN KODAK COMPANY
Graphic Reproduction Division, Rochester 4, N. Y.
Gentlemen: Please send me a free copy of your new booklet on Kodagraph Reproduction Materials.

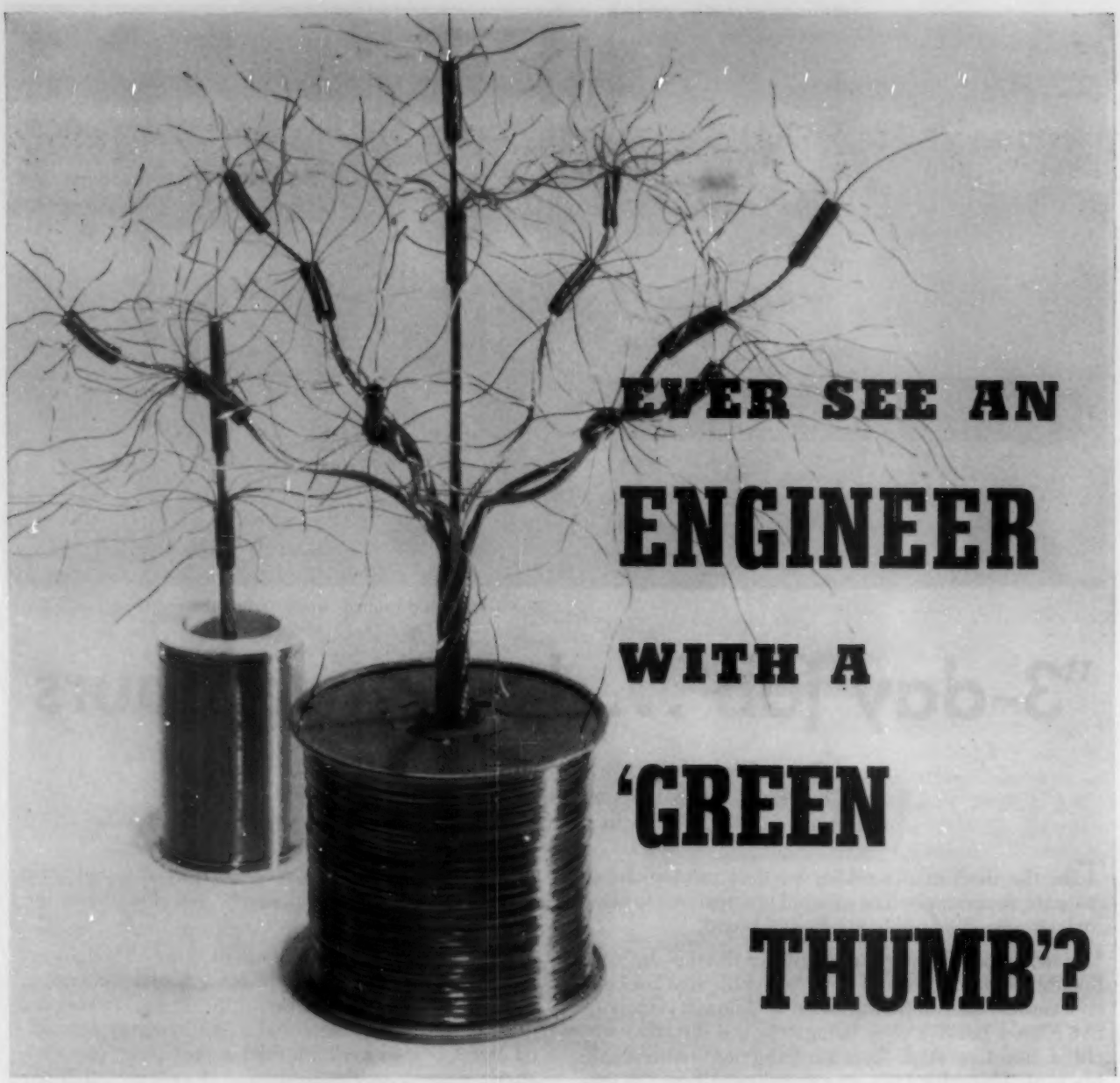
Name_____ Position_____

Company_____

Street_____

City_____ Zone_____ State_____

Kodak
TRADE-MARK



EVER SEE AN ENGINEER WITH A 'GREEN THUMB'?

Fort Wayne Metals' engineers are not v[illegible] able to raise precision stainless steel wire in greenhouses, but they DO have green thumbs in the ways of research.

The "potted plants" above are serious (almost sensational) growth features of the research program. Until FWM made its strength analysis tests, inspired by the "plants", it had not been possible to quantity produce cabling with a predictable, consistent strength exceeding about 75% of that obtained when component strands were tested individually.

By careful study of the different functions of each strand under stress, FWM's engineers and metallurgists devised a "selective tempering" process, which increased cable strength to 85% and even higher.

These results mean that in many cases stainless steel wire cabling of equal strength can now be up to 15% lighter, a critical factor where weight reduction is important. Furthermore, FWM's process nearly DOUBLED cable fatigue performance values.

It is altogether possible that we can help with your problems if they involve stainless steel wire. Why not drop us a line in any event so that we may send you our brochures and tell you about the uses of "selective tempering."

Producers of Precision Stainless Steel Wire for: Aircraft Cabling, Industrial Wire Cloth, Filters, Shock Absorbers, Flexible Tubing, RF Shielding, Brushes, Thread Inserts, Springs, Scouring Pads, Magnetic Recording, and Abrasive Applications.

FORT WAYNE METALS, INC. 3211 MACARTHUR DRIVE
FORT WAYNE, INDIANA

Represented Nationally and Abroad

products of progress in the air

Precision "O" Rings

Both the "Pogo" by Convair and "O" Rings by *Precision* are symbolic of aviation progress and leadership in America.

The "Pogo" combines the advantages of the helicopter and conventional fighter to overcome problems of take-off and landing space. *Precision* "O" *Rings* combine the advantages of light weight, compact design and toughness to overcome problems of speed, temperature and synthetic lubricants in fuel and hydraulic systems.

Compression-molded, rigidly inspected *Precision* "O" *Rings* are the finest ever made! Put *Precision* in your new plans!

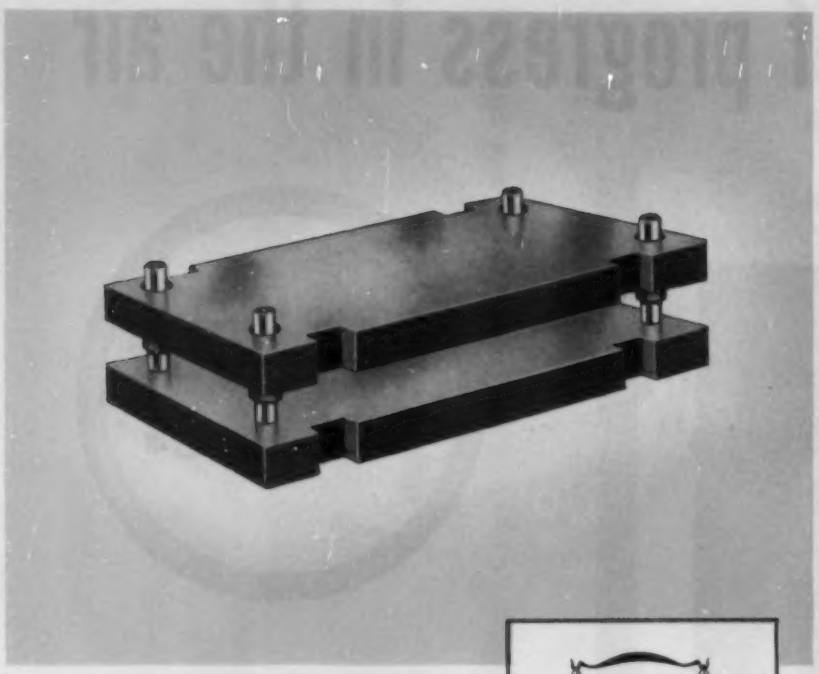
FREE Write for your personal copy of our Handbook on "O" Rings.

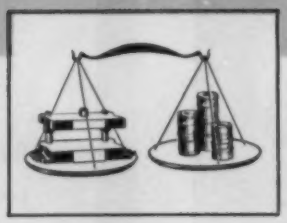
Precision Rubber Products CORPORATION

"O" Ring and Dyna-seal® Specialists

Dept 3 Oakridge Drive, Dayton 7, Ohio

Canadian Plant at: Ste. Therese de Blainville, Quebec





FASTER DELIVERY *on Both* SPECIAL and STOCK DIE SETS

Now . . . you can get into production faster with a Detroit special or standard die set. *First,* because of our greatly expanded facilities, we are now making delivery in less time. For instance, a standard die set will be shipped within 24 hours; specials in remarkably short time. *Second,* because every *full-value* Detroit die set is built up to our high standard and not down to a price and is factory-tested to specifications. Such precision gives you faster mounting without the delay and cost of reworking the set in your shop. Why not talk things over with our nearby representative? Write today.

"full value"

means that in a special or standard Detroit die set you get what you pay for . . . the exact, specified thickness of both die holder and punch holder, true parallelism of surfaces, precision fit of pins and bushings — all assured by precision manufacture, factory assembly and factory inspection.

•

PRECISION-BUILT ACCESSORIES

In stock for immediate delivery is an extensive range of die-makers' accessories, including the new self-oiling guide pin bushings.

Detroit DIE SET CORPORATION

2895 W. GRAND BOULEVARD • DETROIT 2, MICHIGAN

Offices in Principal Industrial Centers

Electric Power, Control

230 v. Control band width can be adjusted from the front of the instrument from approximately ½ to 4 per cent of the scale range. West Instrument Corp., 4363 W. Montrose St., Chicago, Ill.

For more information— Circle 60, inside back cover

Magnetic Servo Amplifier

This 6 w, 115 v, 400 cps magnetic amplifier is designed for instrument type air-borne servo systems. The unit operates directly from a synchro control transformer or potentiometer, without preamplifier or demodulator. A three-stage fast response half-wave bridge circuit is used which is capable of a 20 cycle bandwidth when driving a BuOrd Servo Motor Mk 7 in a closed loop system using simple circuitry. This hermetically sealed amplifier has less than a 0.07 v drift with respect to wide changes in line voltage and frequency or temperature. Weight is 1.7 lb. Specialties, Inc., Skunks Misery Road, Syosset, N. Y.

For more information— Circle 61, inside back cover

Transistor-Equipped Magnetic Servo Amplifiers

This line of transistor magnetic servo amplifiers have only static components and are characterized by absence of filaments, high sensitivity and high input impedance. They are available for practically all of the standard servo motors for operation on 400 or 60 cps. Ambient temperature range of −50 C to 71 C is

(Continued on page 274)

Automate for top performance with . . .

T-J Spacemaker CYLINDERS

CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
T-J
T-J
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

Style SM5 shown

- The Only Cylinders with all the Extras as Standard
- Oil pressure to 750—AIR to 200 P.S.I.
- New Compact Design . . . Saves up to 40% Space
- Proven Performance . . . with Extra High Safety Factor
- Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Hard Chrome Plated Bodies and Piston Rods (Standard)
- Only from T-J can you get these new ingenious cushion designs

More and more of industry's automation problems today—solved with T-J Spacemaker Cylinders! New compact design and many more plus features for a new high in efficient cylinder performance and dependability. Wide range of styles, capacities . . . to help you *save labor, reduce costs* on all kinds of push-pull-lift jobs. Send for bulletin SM-155-1. The Tomkins-Johnson Co., Jackson, Mich.

OFF SHELF DELIVERY

Member of the National Fluid Power Association

T-J TOMKINS-JOHNSON

RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

Examine the evidence...

Century

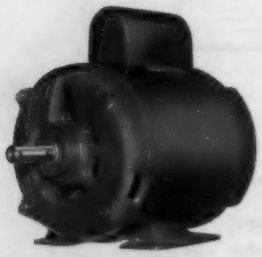
FRACTIONAL HORSEPOWER MOTORS

Superior performance in a smaller "package"

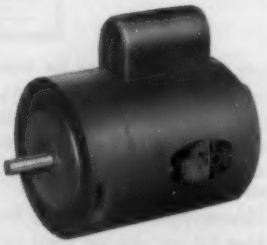
Totally Enclosed
Fan Cooled

Century Fractional Horsepower Motors are quiet running, precision balanced and unusually free from vibration. They can be Performance-Rated to your specific needs in split-phase, capacitor and polyphase types with the following mechanical modifications:

Open Type Drip Proof
with Cushion Base



Open Type Drip Proof
with Rigid Base



Can Be Furnished with
Bracket or Flange Mounting

Century application engineers or authorized Century distributors are always at your service to help you fit a Performance-Rated motor to your job.

ROTOR

practically indestructible, high-pressure die-cast aluminum squirrel-cage rotor... assures uniform cross section of winding. Large capacity fans are cast integrally with the rotor winding for improved ventilation.

INSULATION

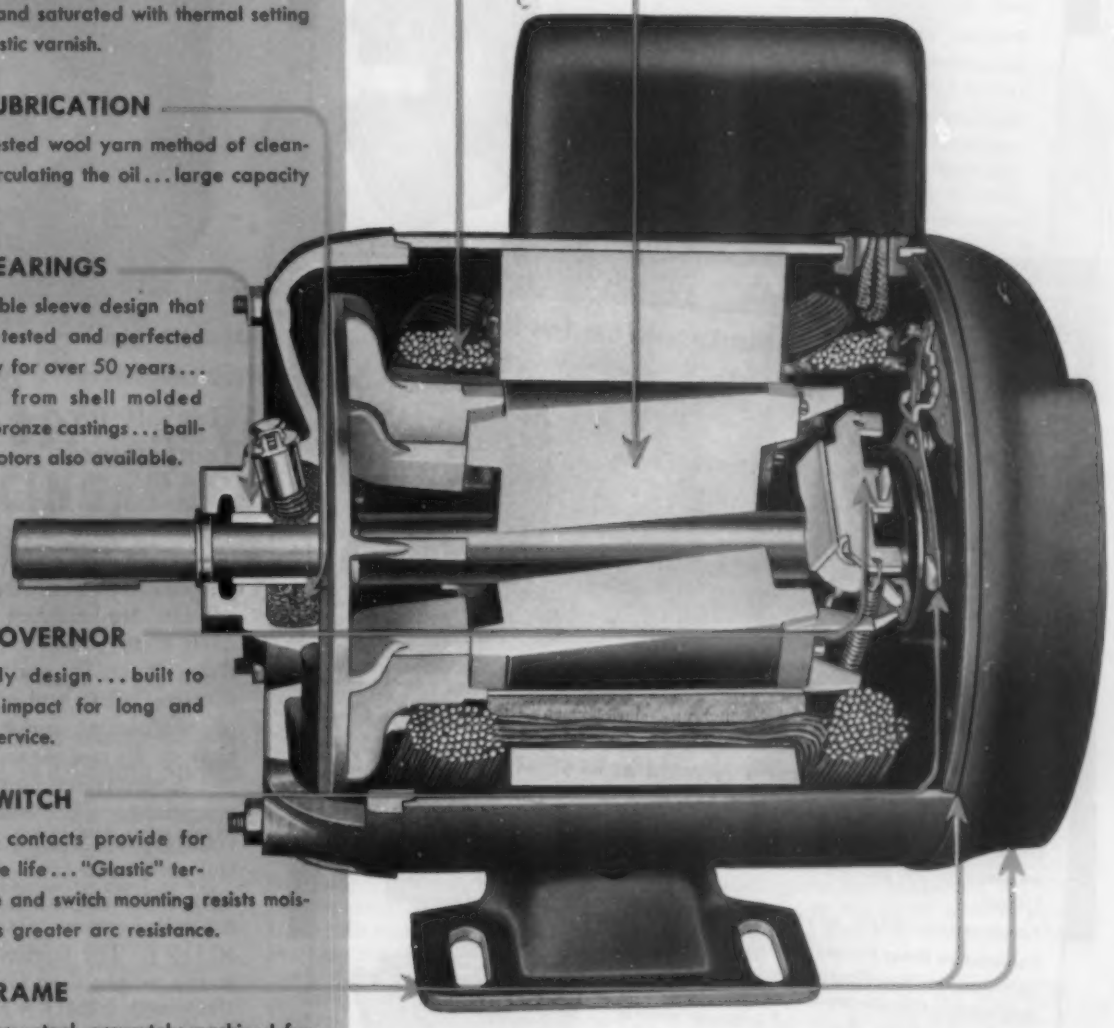
stator winding slots are insulated with laminated rag stock paper and costly "Mylar." "Formvar" plastic insulated wire is used for the coils. The complete stator winding is dehydrated and saturated with thermal setting baked plastic varnish.

LUBRICATION

the time-tested wool yarn method of cleaning and circulating the oil... large capacity reservoir.

BEARINGS

same reliable sleeve design that has been tested and perfected by Century for over 50 years... machined from shell molded Phosphor bronze castings... ball-bearing motors also available.



GOVERNOR

new, sturdy design... built to withstand impact for long and accurate service.

SWITCH

coin-silver contacts provide for long service life... "Glastic" terminal base and switch mounting resists moisture... has greater arc resistance.

FRAME

heavy gauge steel. accurately machined for close-tolerance fit with the cast iron, drip proof end bracket. Base is welded to the frame and the bottom is milled for solid mounting and accurate centering.

CE-22

Performance-Rated® MOTORS
1/8 to 400 H. P.

CENTURY ELECTRIC COMPANY

1806 Pine Street, St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

3 JOHN CRANE "Pressed-In" SEALS

for economy, quick installation and life-long performance in all types of service

TYPE 11-A

Synthetic Rubber Bellows • Small shafts to ¾ in.

Services: hot or cold water, oil, gasoline, kerosene and other liquids non-injurious to synthetic rubber.

Pressures: up to 50 psi.

Temperatures: –65°F. to +220°F. Special construction to +300°F.

Construction Data: Packaged unit. Retainer does not contact shaft, permitting operation at a high rpm. One size can be used for several shaft sizes. Bellows encloses spring and metal parts to prevent contact with medium being sealed.

TYPE 6-A

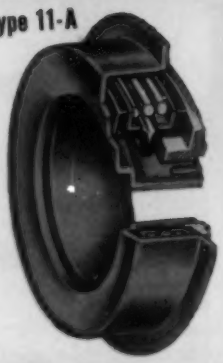
Synthetic Rubber Bellows • Interchangeable with Type 11-A

Services: hot or cold water, oil, gasoline, soapy and other liquids non-injurious to synthetic rubber.

Pressures: up to 75 psi.

Temperatures: –65°F. to +220°F. Special construction to +300°F.

Construction Data: Similar to Type 11-A. Does not contact shaft, permitting operation at high rpm. One size can be used for several shaft sizes. Spring and metal parts available in stainless steel or bronze.



TYPE 9-A

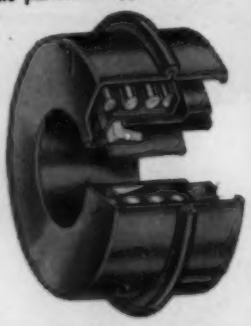
Sealing Members Made of Teflon* • Engineered for the particular application

Services: all chemicals, solvents, oils, corrosives and gases, hot or cold.

Pressures: to 150 psi. Balanced construction to 750 psi.

Temperatures: –120°F. to +500°F.

Construction Data: Packaged unit. Furnished in metallurgical specification best suited to the application. Chemically-inert Teflon wedge ring closely fits inner sleeve of retainer and is machine-mated to carbon sealing washer.



Contact "John Crane" for the particular seal best suited to your application. Request bulletin giving full information on "John Crane's" complete line of mechanical seals.

Crane Packing Co., 1845 Cuyler Ave., Chicago 13, Illinois.

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

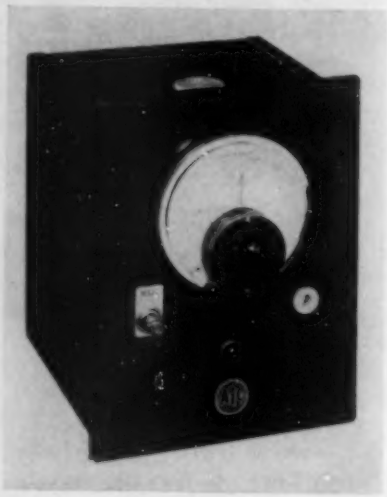
*DuPont trademark

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

Electric Power, Control

standard, although higher temperature units are available. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.

For more information—
Circle 62, inside back cover



Controls Process Temperature

Operating on a current of less than 1 microamp, a temperature-indicating, electronic contact-controller is said to automatically hold and control process temperatures as high as 2500 F to within ±1 per cent of scale. It can be used with industrial furnaces, ovens, tanks or similar types of production equipment and machinery. Its case measures 6 x 7⅜ x 5⅜ in. A pyrometer unit indicates the temperature under control up to the control point and an electronic control unit opens and closes the load relay regulating fuel supply to the controlled process. Capacity is 5 amp at 115 v. The controller is available in five ranges: 0 to 600, 1000, 1500, 2000, and 2500 F. Automation Instrument Corp., 1516 Summer St., Philadelphia 2, Pa.

For more information—
Circle 63, inside back cover

Moving Coil Instruments

Precision (±0.5 per cent) moving coil ammeters, milliammeters, microammeters, galvanometers, voltmeters, millivoltmeters and electrodynamometers single and three-phase (both three and four-wire) wattmeters from

(Continued on page 280)

WHO

Says Tracing Papers Are All Alike?

See for Yourself the Wonderful Difference in Bruning's Transparentized

No. 357 "KOVEL" TRACING PAPER!

Send for Your Free Trial Sheet Today!

Here's a challenge you'll be glad you accepted. Test the tracing paper you're now using against Bruning's general purpose No. 357 "Kovel" Tracing Paper. You'll discover a wonderful difference that will pay off for you in neater, higher quality drawings and cleaner, sharper, faster prints.

You'll like the greater translucency of "Kovel" brought by an improved transparentizing agent and technique of application. Yet you'll find this vellum-type paper exceptionally strong and durable, able to withstand repeated erasures without losing workability. You'll take pure pleasure in the ease with which the beautiful fine-grained surface takes pencil, also accepts ink, gives you smooth, clean, opaque lines. And its faint blue tint eliminates glare. "Kovel" is great for reproduction, whether used for print making immediately or years later. No leaching, no discoloring, no odor . . . even after long periods of storage.

Send for your free trial sheet today. Discover for yourself the big difference, except in price, that has gained "Kovel" acceptance as the finest general purpose tracing paper of its type on the market.

For all the advantages of "Kovel" in a thinner, untinted white paper, try No. 354 "Frenchvel" Tracing Paper. The high translucency of "Frenchvel" makes it ideal for tracing from weak-lined drawings or blueprints and for higher volume reproduction.

And for a Wonderful Difference in a Smooth Surface Paper, try . . .

BRUNING'S No. 350 "VELLUX"

The moment you put pencil, or ink, to this smooth-surface, vellum-type tracing paper, you'll see what a difference quality can make. This permanently white, transparentized paper is unsurpassed for textural uniformity and for fine all-around performance. Prove the difference to yourself by sending today for your free trial sheet.

BRUNING

America's Largest Supplier of Engineering and Drafting Equipment

CHARLES BRUNING COMPANY, INC., 4700 MONTROSE AVE., CHICAGO 41, ILL.

In Canada: Charles Bruning Company (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 114-0
4700 Montrose Ave., Chicago 41, Illinois

Please send me my 8½ x 11-inch trial sheet of

☐ No. 357 "Kovel" ☐ No. 354 "Frenchvel" ☐ No. 350 "Vellux"

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

You can set a new High-Torque Unbrako self-locking socket set screw and forget it—it stays tight

There are several reasons: the deeper socket which gives you better purchase with the wrench; the rounded socket corners which eliminate the sharp corners where cracks start; the special methods of heat treatment in atmosphere-controlled furnaces; the development of fully formed threads.

Up to 40% higher tightening torque— a new Unbrako feature

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES (Inch-Pounds)

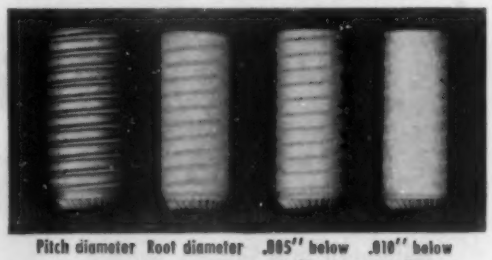
SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

ALL UNBRAKOs can withstand higher tightening torques than ordinary set screws. For example, the recommended torque for a ¼" UNBRAKO is 87 inch-pounds—40% greater than that recommended for an ordinary set screw.

These microphotographs illustrate just what fully formed threads do for the new High-Torque UNBRAKO. They make the whole screw stronger. The metal is compressed into the closely knit grain structure that you see. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

You can't buy a better set screw than an UNBRAKO. See your authorized industrial distributor today. Or write STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

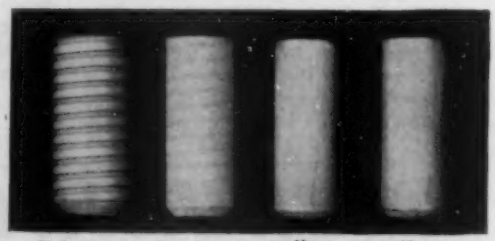
Unbrako Set Screw



Pitch diameter | Root diameter | .005" below root diameter | .010" below root diameter

Fully formed threads make the whole screw stronger. The metal is compressed into a closely knit grain structure. The grain flow follows the contour of the threads. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

Ordinary Set Screw



Pitch diameter | Root diameter | .005" below root diameter | .010" below root diameter

STANDARD PRESSED STEEL CO.

UNBRAKO SOCKET SCREW DIVISION SPS JENKINTOWN PENNSYLVANIA

OHMITE®

AMRECON® *Relays*

HIGH QUALITY, ALL-PURPOSE RELAYS... RUGGED, DEPENDABLE FOR LONG LIFE!

Current ratings up to 25 amp, AC or DC

Also made-to-order models in many contact combinations and coil voltages.

61 types in three stock models

Ohmite Amrecon relays have proven their exceptional ruggedness and long life in years of service. Now, three popular stock models—DOS, DO, and CRU, in 61 different types—are available from stock.

Models DO and DOS fill many industrial needs for a compact, lightweight relay that handles power loads usually requiring much larger, heavier units. They are particularly adaptable to aircraft and mobile equipment where severe shock and vibration are encountered. At 115 VAC or 32 VDC, noninductive load, Model DOS has a contact rating of 15 amp; Model DO, 10 amp; and Model CRU, 5 amp. Available in a wide range of coil operating voltages and contact combinations.

HERMETICALLY SEALED OR DUST-PROTECTIVE ENCLOSURES

SEND FOR CATALOG R-10

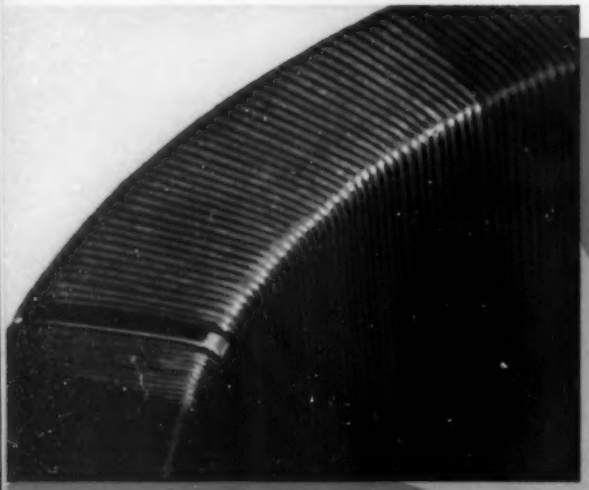
Be Right with

OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

OHMITE MANUFACTURING COMPANY
3611 Howard Street, Skokie, Illinois
(Suburb of Chicago)

OHMITE® RHEOSTATS HAVE *Smoother Windings!*

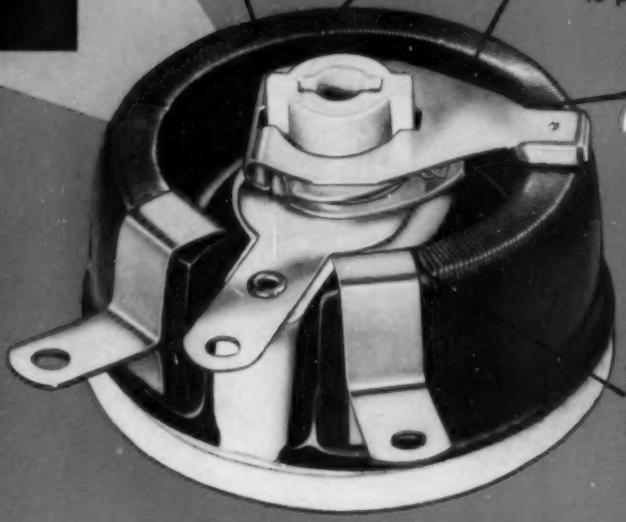


5 REASONS WHY—

1. PRECISION GROUND CORE . . . Cores for fine wire, high resistance units are ground to give a smooth, flat contour for the contact brush.

2. SMOOTH JUNCTIONS where wire sizes change between sections of tapered windings . . . less differential between wire sizes.

3. PERMANENTLY LOCKED WINDINGS . . . Core and windings are bonded together with vitreous enamel to prevent shifting of wire.



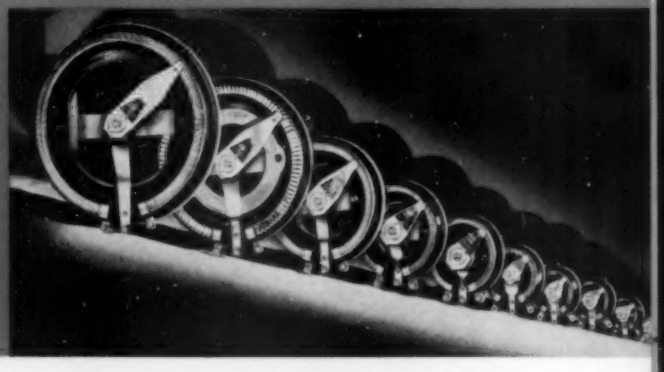
4. UNIFORM WIRE SPACING . . . Ohmite has developed special winding machines to insure uniform spacing and eliminate crossover of adjacent turns on fine wire units.

5. FLUSH TERMINALS . . . Terminals are flush with windings . . . brush glides smoothly from windings to terminal.

See for yourself! Examine an Ohmite Rheostat first hand. Compare its smoother resistance windings. Turn the knob and note how easily and smoothly the contact brush glides over the rheostat windings.

There's less wear on the resistance wire and on the contact brush. The brush makes contact with all of the turns and the resistance varies smoothly and uniformly as the shaft is turned. Every Ohmite Rheostat is *individually tested* on ultrasensitive electronic instruments to assure perfect contact between the winding and the contact brush.

Standardize on Ohmite Rheostats for unsurpassed dependability, smoothness of operation, and long life.



A COMPLETE LINE OF RHEOSTATS

from 25 to 1000 watts. Also available to meet MIL-R-22A requirements in *each* of the 26 type designations.

Write on company letterhead for Catalog and Engineering Manual No. 40.

Be Right with **OHMITE®**

OHMITE MANUFACTURING COMPANY, 3611 Howard Street, Skokie, Illinois (Suburb of Chicago)

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

(Advertisement)

How to Control Temperature With Liquid Filled Bellows Systems

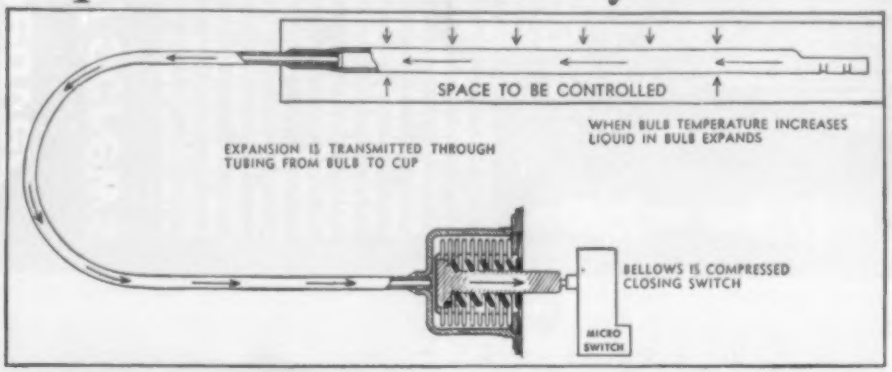


Fig. 1. Liquid filled bellows systems provide remote control of a wide temperature range with a single adjusting device. Bellows actuating movement is closely proportional to the temperature range throughout the entire operating range of the system. The differential required to operate these devices is directly related to the range of temperature to be controlled. A device that provides control over a wide temperature range normally requires a relatively wide differential to operate it at any given setting. However, proper design of switches or valves can make these systems quite sensitive.

ADVANTAGES OF LIQUID FILLED BELLOWS CONTROLS

For the remote control of temperature, liquid filled bellows assemblies provide simple, efficient, direct-acting systems. Utilizing the thermal expansion of a liquid selected for the particular application, the bellows responds with sufficient force and degree of motion to actuate switches and valves without the need for elaborate amplifying systems.

They can be used for temperatures as low as —100 F. and as high as 700 F. In addition, these units provide "one knob control" of temperature over a *wide range*. A common example is the ordinary domestic oven in which a selected temperature can be maintained anywhere in the range from 150 F. to the top limit of the oven — usually about 600 F.

Since these systems operate on the thermal expansion of a liquid, they are insensitive to ambient pressure changes.

Liquid filled bellows systems are highly versatile and offer many possibilities to designers seeking low cost, accurate, dependable temperature controls for consumer, industrial or commercial product applications.

Long experience record. Being one of the most widely used thermostatic controls, a great deal is known of the inherent characteristics of liquid filled thermostatic assemblies. Performance can be accurately predicted for applications when operating conditions are known. Furthermore, the design considerations are so well known that it is usually not difficult to design a liquid type thermostatic assembly to fit the requirements of any application for which this type of control is suited.

Operating principle. (fig. 1). In its simplest form, the liquid filled thermostatic assembly consists of a bulb, capillary and bellows. The bulb is the temperature-sensing element and is located in the chamber whose temperature is to be controlled. The bellows is the responsive element and can be located together with the switch or valve it will actuate at any remote location a reasonable distance from the bulb. A capillary, a special small bore tubing, connects bulb and bellows. The entire assembly — bulb, capillary and cup — is completely filled with a liquid chosen for the particular range of temperature to be controlled.

As the temperature in the chamber rises, the liquid in the bulb expands through the capillary into the cup, compressing the bellows and moving the attached rod to actuate a switch or valve.

DESIGN CONSIDERATIONS

Bellows stroke. The amount of bellows movement necessary to actuate the switch or valve varies with the nature of the application. Design of bulb volume and bellows effective area control the movement to meet these requirements. A large volume bulb and small bellows results in a long stroke and vice versa. Bellows of 15/32" or 9/16" diameter are common sizes.

The total stroke or travel to be expected of a bellows in this type of application is approximately 25% of its length.* This is the total amount of bellows movement available over the entire range of temperature which the device will encounter.

For example: a bellows one inch long will provide a total travel of about one-quarter inch.* Used in a temperature range of 500 F, total bellows movement would be 0.250" or 0.0005" per degree. In a 100 F range, movement per degree would be .0025".

In computing bellows movement care must be exercised to consider the highest ambient temperatures encountered during shipment, storage or extraordinary conditions of service. Heat applied to a fluid in a closed system can generate large forces and result in damage. A unit intended to control temperatures between 50 F and 70 F for example, may experience temperatures as high as 140 F. Bellows movement must therefore be figured for the range 50 to 70 F resulting from expansion of the liquid in the bulb (considering temperature of the bellows held constant at 70 F.) In addition, the entire volume of liquid in the bulb, bellows and capillary will expand between 70 and 140 F.

$$\therefore \Delta V_{tot} =$$

$$K[V_s \Delta T_c + (V_c + V_b + V_s)\Delta T_{max}]$$
$$= K[V_s(70 - 50) + (V_c + V_b + V_s)(140 - 70)]$$

where

K = Coefficient of expansion of fluid
V_s = Volume of thermal sensing bulb
V_b = Volume of bellows
V_c = Volume of capillary
ΔT_c = Control temperature range
ΔT_{max} = Ambient temperature range
ΔV_{tot} = Total liquid expansion

This expansion divided by the effective area of the bellows will give the total movement over the complete range from 50 to 140 F. The total movement should not exceed the allowable travel discussed above. Temperature *lower* than the operating range need not be considered as a factor.

* *For accurate information, refer to bellows table of characteristics obtainable upon request*

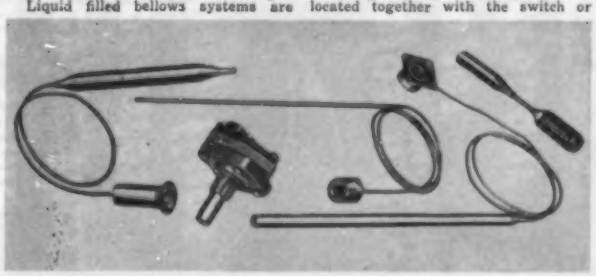


Fig. 2. Representative open type and cup type filled bellows thermostatic assemblies. Cup type is preferable, being inherently stronger, easier to mount and with bellows protected from damage by handling.

Fig. 3. Electric and gas ranges are commonly equipped with liquid filled bellows controls. Bellows movement operates electric switches that turn heating elements on and off. In gas ranges bellows operates modulating valve to control flow of gas.

Fig. 4. Control of temperature for many industrial processes is achieved through liquid filled bellows assemblies. Typical applications: Kilns, steam tables, kettles, ovens, furnaces.

Photo courtesy of United Electric Controls

Loading springs are generally used with liquid filled bellows systems. They make certain that the bellows follows the volume changes of the liquid accurately. Springs used for cup type assemblies are lighter than those required for equivalent open type assemblies (see fig. 2) because the natural spring of the bellows in a cup assembly actually helps the loading spring to perform its proper function. The open type bellows assembly opposes the loading spring and therefore, a heavier loading spring is required. Frictional forces for devices utilizing cup type assemblies are generally lower than those for equivalent open type units.

Bulb and filling medium. There are a number of liquids with properties suitable for use in thermostatic assemblies intended for service anywhere from —100F to 700 F. Some typical ones are shown in fig. 7. In addition to the consideration of adequate volume in relation to the bellows so as to provide sufficient actuating stroke, bulb design is concerned with securing the proper heat transfer so that temperature changes in the controlled chamber will be quickly reflected in bellows movement. Both filling medium and bulb design are critical elements and should be chosen only after consultation with Clifford engineers.

Responsiveness of liquid filled bellows assemblies is very good and they can be used in systems requiring rapid response. The only heat required to change the temperature of the bulb is that required by the specific heat of the bulb material and its enclosed liquid. Much depends upon the specific conditions of the application. In rapidly moving air, for example, time constants as low as 10 seconds are practical. When the bulb is immersed in a liquid the device may operate up to five times as fast.

The open type thermostatic assembly is used for some applications where cup type (fig. 1) may not fit. Operating principle is the same except that the bellows itself is filled with liquid and expands with rise in temperature to actuate the switch or valve rather than being compressed as in cup type.

Open assemblies require a heavier loading spring than the cup type. The bellows is more susceptible to damage due to handling and it is more difficult to mount this type of assembly. Cup assemblies are more rugged. They protect the bellows and apply the pressure to its outside surface. The bellows operates in compression — for which it is best suited—resulting in longer life.

Method of adjustment Since liquid expansion with temperature is inexorable and produces great forces, adjustment of the system within its control range must be accomplished by providing for shifting the position of the switch or valve.

If you have an immediate problem, send a sketch showing controlling conditions. Clifford will send you additional data and recommend a suitable control.

Clifford Manufacturing Company, 139 Grove Street, Waltham 54, Mass. *Division of Standard-Thomson Corporation.* **Sales Offices in New York, Detroit, Chicago, Los Angeles, Waltham, Mass.**

Coefficients of Thermal Expansion

	Coefficient* (in.³/in.³/deg F) × 10^{-6} 0 1 2	Freezing Point (°F)	Boiling Point (°F)	Max. Op. Temp. (°F)
Mercury		− 38	675	
N. T. A.†			672	600
Glycerine			556	350
N. T. C.†		29	528	700
N. T. B.†		54	500	700
Trichlorobenzene		45	415	450
O-Toluidine		1	392	450
Ethylene Glycol		11	386	250
Aniline		− 22	364	450
O-Dichlorobenzene		2	357	450
Chlorobenzene		− 35	271	450
Turpentine			311	350
Xylene		− 52	283	400
Monochlorobenzene		− 50	269	450
Glycerine-Water (67.36 vol.)		− 65	225	200
Toluene		− 139	231	400
Water		32	212	
Trichloroethylene		− 99	188	250
Benzene		42	176	300
Ethyl Alcohol		− 174	173	200
Carbon Tetrachloride		9	170	250
Methyl Alcohol		− 143	148	300
Chloroform		− 82	142	250
Acetone		− 138	133	250
F-113		− 31	118	250
Methylene Chloride		− 142	104	300
Ethyl Ether		− 177	94	250
F-11		− 168	75	250
Ethyl Chloride		− 218	55	350
F-21		− 197	48	250
Methyl Bromide		− 137	38	250
Butane		− 211	31	400
Sulphur Dioxide		− 105	14	600
Isobutane		− 229	10	600
Methyl Chloride		− 144	11	600
F-12		− 247	22	250
Ammonia		− 107	28	
Propane		− 310	44	600

* Values increase with temperature; for example, coefficient for trichlorobenzene ranges from 0.00044 in the region of its 45 F freezing point to 0.00078 at its recommended maximum operating temperature, 450 F.

† Special high-temperature service compounds.

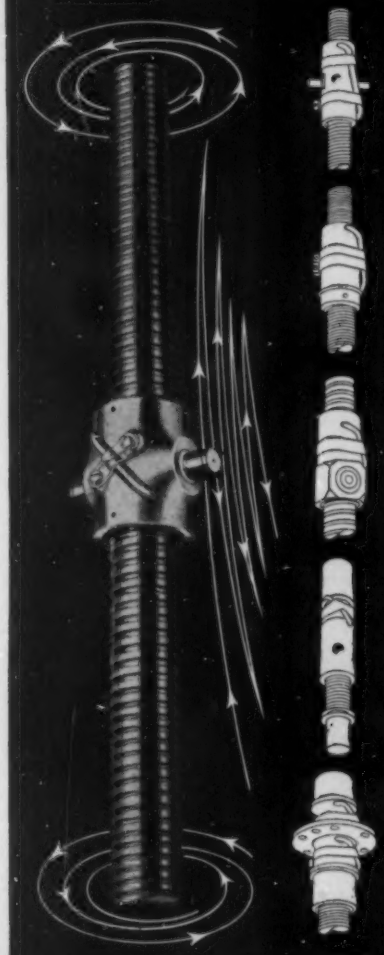
Fig. 6. Representative filling mediums for liquid type assemblies.

Fig. 5. Steam regulators are typical applications for liquid filled bellows assemblies. Cross section shows a Leslie Temperature Regulator used in cooling service. The rugged thermostatic element is adjustable over a temperature range of more than 400 F degrees.

HYDRION
CLIFFORD
MANUFACTURING CO
WALTHAM, MASS

beaver ball screws

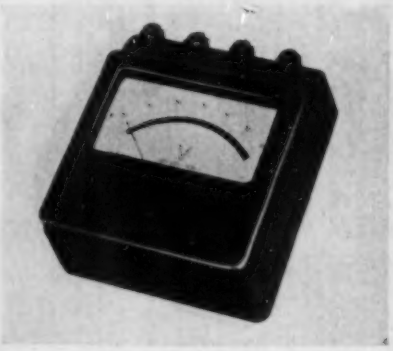
Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficiency in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments to massive wind tunnel jacks. Any diameter or travel: indexing, inching, traversing. Literature, consulting engineering service available.



Fastest growing source for ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

Electric Power, Control



Vienna are available for ac and dc. With the aid of accessories, currents as high as 300 amp may be measured. The millivoltmeters can be converted to high frequency ammeters (ranging from 50 amp at 800 kc to 200 ma at 50 mc) by means of separate thermotransformers. All units have mirror scales, knife-edge pointers, weigh 1.5 lb and measure 5½ x 5 x 2¼ in. Physics Research Laboratories, Inc., 507 Hempstead Turnpike, W. Hempstead, N. Y.

For more information—
Circle 64, inside back cover

Panel Meter With 6 x 2½ In. Face

This meter with its 6 in. dial arc length is available as a moving coil permanent magnet type in all d-c ranges, nominal 2 per cent accuracy, available to ½ per cent as the application requires. A variety of scale ranges permits its use as a basic component in various types of equipment. Marion Electrical Instrument Co., Manchester, N. H.

For more information—
Circle 65, inside back cover

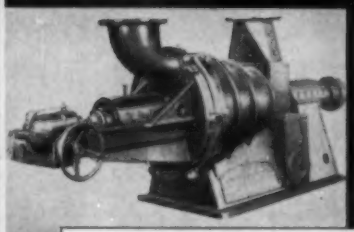
Thermometer With Matching Reading Disks

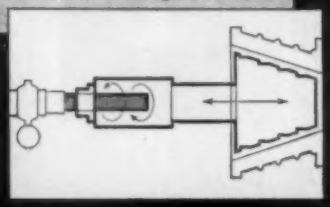
A bright red disc is affixed to the pointer of this instrument and an opaque disc of the same diameter is attached to the dial glass over the spot where it exactly coincides with the red disc. Slightest temperature variation causes the pointer to fluctuate over or below the opaque circle, thus revealing the red signal eye to the observer.

These thermometers are available

(Continued on page 284)

The same device that operates wing flaps helps make paper stronger



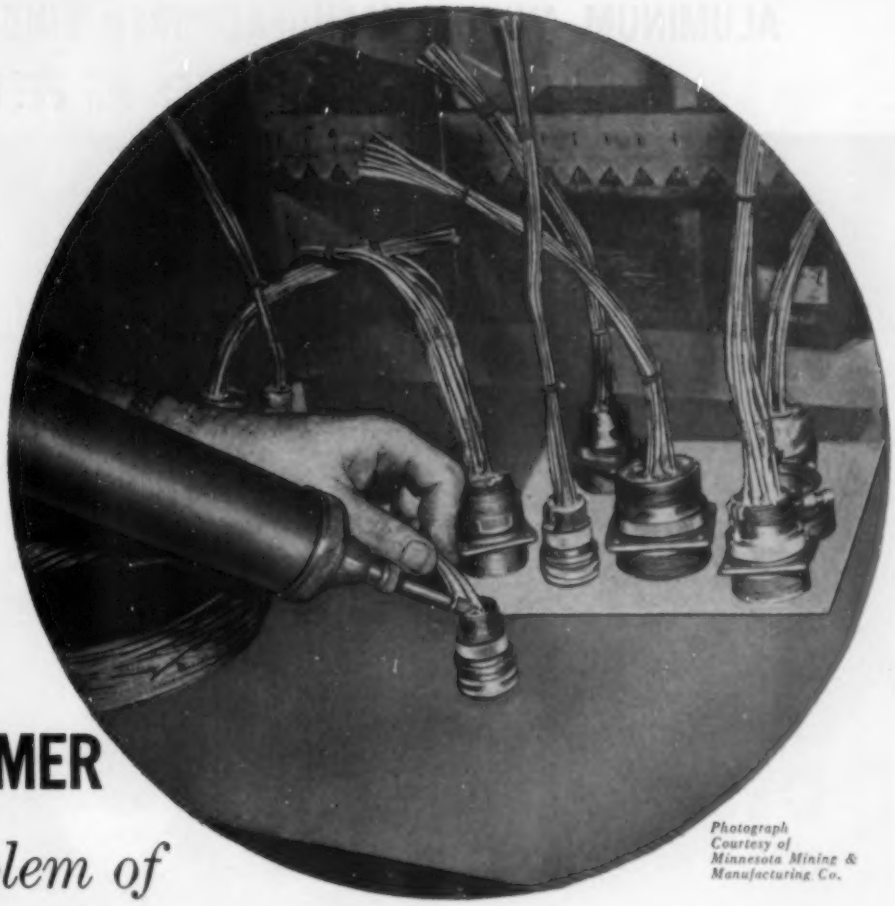


Beaver Ball Screw mechanisms have been selected by Shartle Bros. Machine Division, Middletown, Ohio, for the control unit in their line of jordaners and refiners used in paper manufacture.

WHY? Because Beaver Ball Screws permit fast adjustment for change of stock characteristics by affording easiest manipulation and most positive positioning of the plug.

Can your product be made more efficient with Beaver Ball Screws? Write for literature.

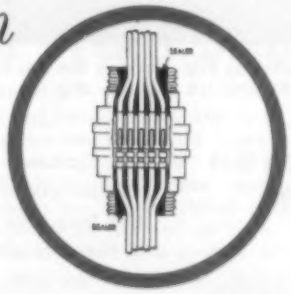
Beaver Precision Products INC.
CLAWSON, MICH.



Photograph Courtesy of Minnesota Mining & Manufacturing Co.

Thiokol.
LIQUID POLYMER

Solves Problem of Sealing Electrical Connectors against Moisture and Vibration



Problems in sealing electrical connectors against moisture, solvents and contamination under conditions of severe vibration and temperature extremes can be solved with potting compounds based on "Thiokol" Liquid Polymer.

"Thiokol" Liquid Polymer potting compound comes in the form of a paste and is pressure flowed into the voids around wiring. It sets at room temperature to a resilient rubber with good dielectric properties and adheres tenaciously to metals, glass and plastics.

The cured rubber maintains an effective seal under vibration . . . temperatures cycling from —65° to + 200° F . . . water and high humidity . . . aromatic and aliphatic solvents . . . weathering and aging.

These properties have helped introduce new standards of reliability and space saving in electrical potting for aircraft, guided missiles and other industrial products. They may do the same in your electrical potting application.

Our technical staff will gladly discuss the suitability of "Thiokol" Liquid Polymer for any electrical potting or sealing job you have in mind.

Thiokol Chemical Corporation supplies "Thiokol" Liquid Polymer only as a raw material. We will gladly indicate sources of suitable compounds to end-users.

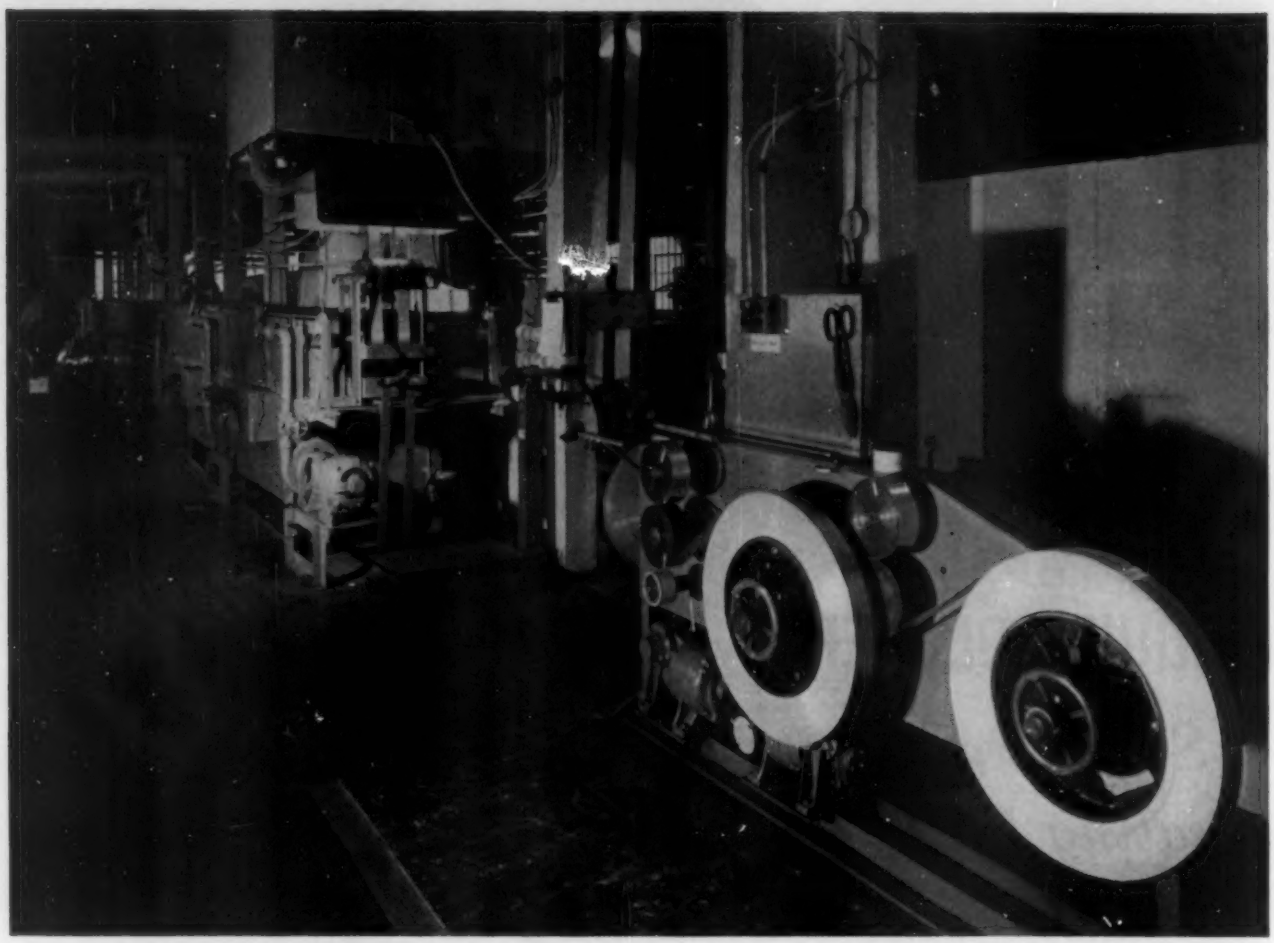
SYNTHETIC RUBBERS
PLASTICIZERS
CHEMICALS
ROCKET MOTORS

Thiokol Chemical Corporation

784 NORTH CLINTON AVENUE • TRENTON 7, NEW JERSEY

In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario

ALUMINUM AWNING MANUFACTURER FINDS ALODIZING 2 TIMES AS FAST, 4 TIMES AS EFFICIENT



The very first continuous strip Alodizing line was installed by Orchard Brothers, Inc., Rutherford, N.J. This view of its plant shows the Alodized aluminum strip leaving the machine and being wound on the reels in the foreground.

Previous process needed more time and finish was too brittle for roll-forming after painting

Before being told about Alodine,® Orchard Brothers, Inc., maker of Alumaroll* awnings, used a crystalline phosphate coating to prepare its aluminum strip for enameling. Not only was this a slow and inefficient process, with many hours of downtime, but it made the finish too brittle to roll-form after painting.

Alodizing with Alodine has had a twofold production benefit: it has cut operating costs about two-thirds and has increased output 50%. And the Alodine coating forms such a durable and tenacious bond that roll-forming of the slats after the enamel has dried does not damage the finish.

Another tangible advantage of Alodizing with Alodine is the technical assistance provided by ACP. Our Engineering and Service Departments not only recommend the proper equipment, but instruct plant personnel in its operation, and check samples of the finished product in our own Quality Control Laboratory.

We can offer the same product advantages to you. Write for complete information today about the process of Alodizing with Alodine.

*T.M. Orchard Brothers, Inc., Reg. U.S. Pat. Off.

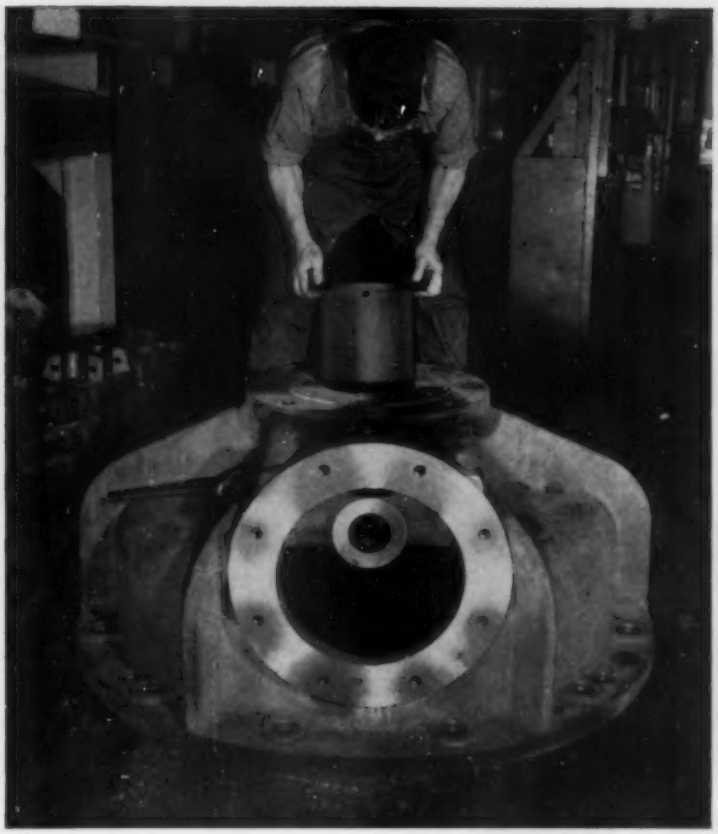
Alodized aluminum awnings chosen for this home have the longevity to outlast the house itself.

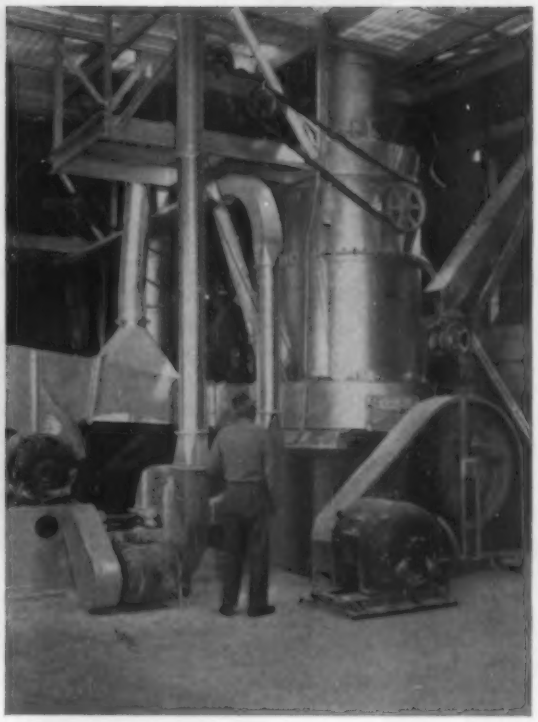
Orchard Brothers, Inc., and American Chemical Paint Co. are Members of National Metal Awning Association

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICHIGAN NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES





• *Big pulverizing mills made by Raymond Division, Combustion Engineering, Inc., depend on Johnson Bronze Bearings for trouble-free performance the world over. At right is a high side roller mill installed in the Kaiser Gypsum Wallboard Plant at Seattle.*

Where One Bearing Can Keep Whole Plant From Shutdown

When you're investing up to $85,000 for a pulverizing mill around which you're going to build an entire plant, you expect to get equipment which will give long, trouble-free performance.

One leading company in the field of designing and manufacturing pulverizing mills for use all over the world makes every effort to do just that—build sturdy equipment of the best available materials which won't break down because of the failure of any one part.

Because bearings play such an essential role in the operation of pulverizing mills, the Raymond Division, Combustion Engineering, Inc., has relied for more than 30 years on cast bronze bearings made by the Johnson Bronze Company of New Castle, Pa.

Johnson Bronze bearings rate high with this Chicago manufacturer because they can be depended upon to keep these expensive units on the job day in and day out and because they are made just the way Raymond Division specifies. That means a very low rejection rate and faster production.

Take the big bronze bearings Johnson makes for journals on a pulverizing mill. They are made to a tolerance of .002 of an inch. Because Johnson consistently meets this specification, the time required to fit the bearing is held to a minimum. A few taps with a rawhide mallet usually slips the bearing into its position.

If your product demands uniformity, investigate Johnson Bronze products. You can depend on them for faster production and longer life in use. Skilled engineers are available to help you decide what type of bearing you need to get the best possible results at lowest cost. Johnson Bronze Company, 508 S. Mill Street, New Castle, Pa.

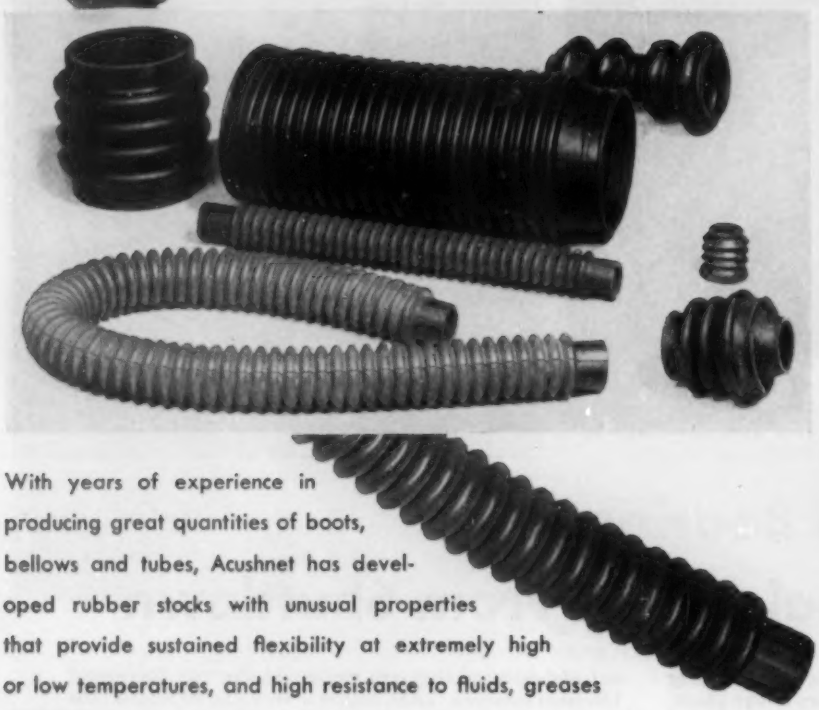
Johnson Bearings

LEDALOYL (powder metallurgy) • ALUMINUM ON STEEL • BRONZE ON STEEL • STEEL AND BABBITT • CAST BRONZE

BOOTS

BELLOWS

TUBES



With years of experience in producing great quantities of boots, bellows and tubes, Acushnet has developed rubber stocks with unusual properties that provide sustained flexibility at extremely high or low temperatures, and high resistance to fluids, greases and gases.

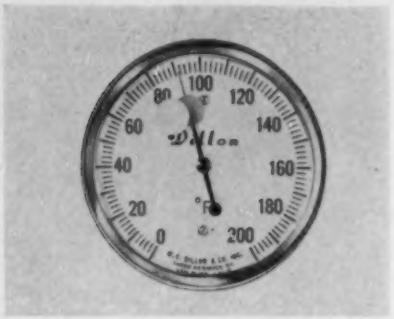
Our precision-molded boots, bellows and tubes give enduring protection to moving parts by excluding dust, dirt, water, oil, etc. — or by retaining grease, oil, fuel — or by performing both functions at the same time over long periods of continuous flexing. These products are made on order to customer specifications — none are stocked.

Acushnet
PROCESS COMPANY

Send for your copy of the "Acushnet Rubber Handbook", a comprehensive rubber data source widely used in industry as a reference for molded rubber parts.

Address all communications to 768 Belleville Ave., New Bedford, Mass.

Electric Power, Control



in 3 or 5 in. dia dial sizes and in stem lengths from 2½ in. up to as long as 72 in. Fahrenheit ranges vary from −40 to 160 F, with intermediate ranges and a high of 200-1000 F. Centigrade ranges run from −10 to 110C and up to 0 to 300 C. All are individually calibrated to an accuracy of 1 per cent the full scale reading. W. C. Dillon & Co., Inc., P. O. Box 3008, Van Nuys, Calif.

For more information—
Circle 66, inside back cover

Digital Ohmmeter

An automatic, digital ohmmeter displays four digits accurate to 0.05 percent, ±1 digit from 0.1 ohm to 1 megohm in four ranges. Average reading time is said to be approximately 1 sec. Overall size of the unit is 7 x 19 in. It is designed to be mounted in standard racks. Electro Instruments, Inc., 3794 Rosecrans St., San Diego 10, Calif.

For more information—
Circle 67, inside back cover

Rectangular Panel Instruments

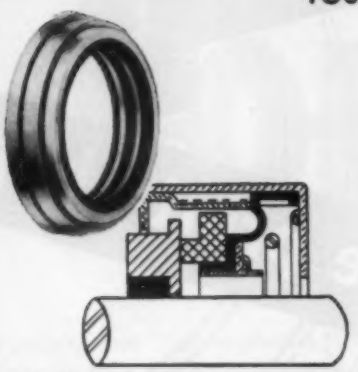
Two lines of panel instruments, 4½ and 5½ in. in size, are available in three types: d-c meters, rf meters, and a-c rectifier-type meters. Each of the three types can be supplied with ex-

(Continued on page 289)

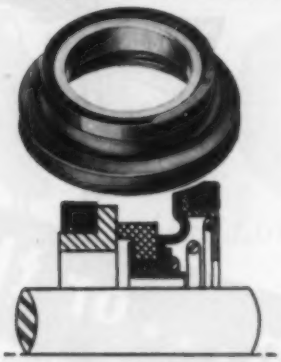
LARGEST STOCK SELECTION AVAILABLE ANYWHERE!

Modern, Mechanical, Face-Type Seals —
Standardized, To Save Time And Money

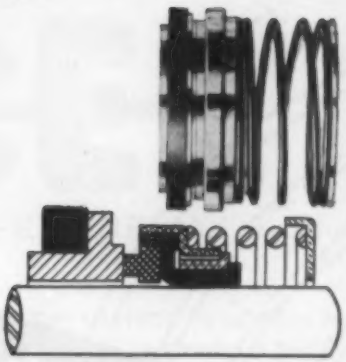
YOUR Sealing Problem Is Solved Here!



STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Important applications in **machine tools** and **power transmission equipment.** Stock sizes for shafts .250 through 4.000.

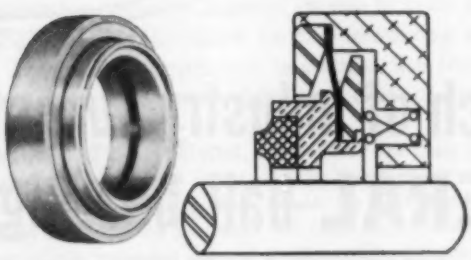


STYLE SGU—A factory-assembled unit-type seal for the small budget user. Widely used in **appliance** field. Stock sizes for shafts .250 through 1.000.

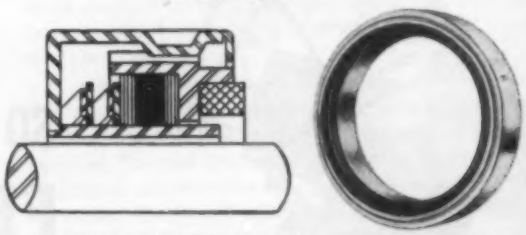


ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Many applications in **pumps** and **compressors.** Stock sizes for shafts .250 through 4.000.

STYLE RFO—A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



STYLE DPC — A high-speed, carbon-faced seal, for use where lubrication is poor or where shaft RPM and resulting friction are high. Ideal in many **machine tool** applications. Stock sizes for shafts .250 through 4.000.



STYLE HH—Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Of particular importance to the **aircraft** industry. Stock sizes for shafts .250 through 4.000.

These are only a few of the countless sealing problems now being solved by

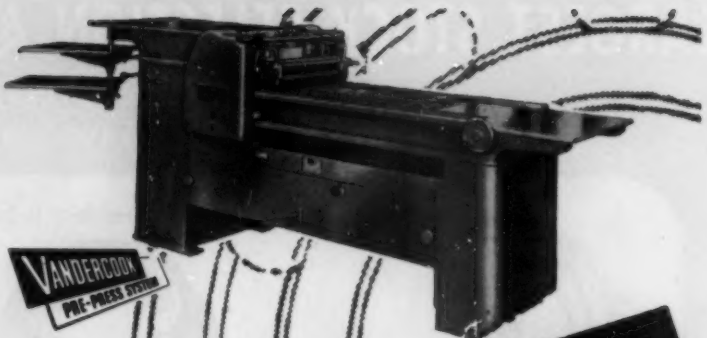
GITS SHAFT SEALS

Write for detailed data on any of these standardized stock Gits Shaft Seals.

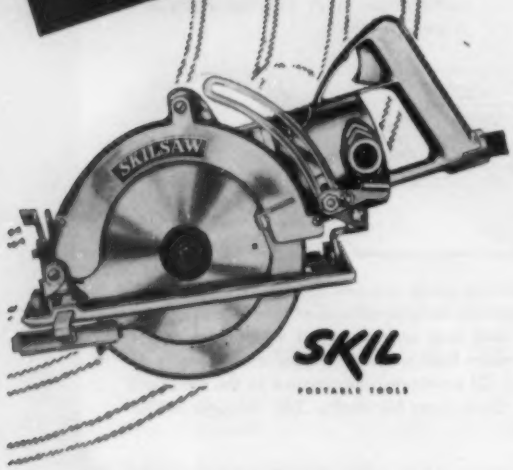
GITS BROS. MFG. CO.
1838-B S. KILBOURN AVE., CHICAGO 23, ILL.

Specialists In Lubricating Devices And Shaft Seals For Almost Half A Century

Color printing demands exacting precision, vibration-free press performance for accurate register of one color to the next. You'll find Federal Bearings here, too.



in the workshop . . . or the print shop



High operating speeds . . . heavy, suddenly applied radial and thrust loads . . . little maintenance or none at all—they're all part of the service conditions Federal Ball Bearings meet in power hand tools.

so much of industry *turns* on FEDERAL ball bearings

In hobbyists' tools and home appliances—in pressrooms and mass-production plants—in farm equipment and business machines—you'll find Federal Ball Bearings quietly and efficiently at work, in some of the hundreds of types and 12,000 sizes that the company has been producing for almost 50 years devoted *only* to making ball bearings.

When Federal Ball Bearings are a part of so many things you *use*, shouldn't they be a part of the things you make?

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, N. Y.

175 fact-packed pages of information on ball bearings are yours for the asking in Federal's Catalog. Just drop us a line for your copy.

Federal BALL BEARINGS

One of America's Largest Ball Bearing Manufacturers

Celanese Corporation of America

Announces

the first commercial production of

FORTICEL*

(CELLULOSE PROPIONATE PLASTIC)

High Performance Thermoplastic Molding Material with Outstanding Range of Balanced Properties... Available in Choice of Colors and Formulations

Forticel is not a new plastic. It was first introduced on a semi-works basis a number of years ago by Celanese Corporation of America, and quickly won a favored position among thermoplastic molding materials. Its unique combination of great strength with form retention literally dictated its use in such standard consumer applications as the telephone set in black or colored, appliance housings, the fountain pen and other end uses subject to personal contact.

AN OVERNIGHT REPUTATION. Applications like these quickly put Forticel in the forefront position among thermoplastic molding materials. Forticel had the qualities needed by molder and manufacturer. In addition to its toughness and dimensional stability, this cellulosic plastic possesses unusual weatherability, surface beauty and permanence, color, and, perhaps as important as anything else, Forticel is free of objectionable odor.

A MOLDER'S PLASTIC. In molding performance, Forticel is outstanding. Flow temperatures are not as critical . . . welds are stronger . . . surface details of molded parts are superb . . . flash lines are all but invisible . . . molded surfaces are lustrous, and require little or no buffing or polishing . . . molded-in metal inserts hold firmly.

A FABRICATOR'S PLASTIC. Forticel also machines well. It can be sawed, cut, drilled, threaded and punched with far less danger of stress lines and crazing. This machinability is of vital importance in such applications as fountain pens and mechanical pencils, toothbrush handles and scale model trains, and appliance housings.

FIRST PRODUCTION OF FORTICEL STOPPED. When originally introduced, Forticel was produced in a pilot plant operation. And, because of the difficulty of obtaining raw materials of acceptable quality and cost, commercial production was delayed until such a time as raw materials could be produced in volume—at a price that would insure a competitive position for Forticel.

PRODUCTION OF THE NEW FORTICEL BEGUN. After continued development, the new Forticel is currently moving into full scale production. More important to molder and manufacturer is the news that the raw materials of Forticel are *Celanese* produced—and in volume!

NEW FACILITIES FOR FORTICEL. To be certain that the supply of Forticel raw materials will be adequate to meet the anticipated demand for this outstanding plastic, Celanese has installed new facilities for their production. This will insure a dependable source of supply. These facilities will produce Propionic Acid and other petrochemicals necessary to Forticel manufacture.

THE NEW FORTICEL. What about the new Forticel? What is it like? What makes it the right plastic for appliance housings, automotive steering wheels, accessories, scale models, sunglass frames, fountain pens, etc.? In the first place, today's Forticel is an even better plastic than its predecessor. This is the result of continued research into the development of new plasticizers, and improvements in processing.

A cellulosic, Forticel has *natural* impact strength or toughness. This is combined with a fine balance of desirable properties including, form retention, low mold shrinkage, weatherability and surface hardness. The new Forticel is available in a full color range, and supplied in uniform pellet size. Sample quantities are available for evaluation. The New Product Bulletin, NP-16 is ready for distribution. This bulletin covers the complete Forticel story from chemical and physical properties to molding and fabricating.

Celanese Corporation of America, Plastics Division, Dept. 103K 290 Ferry Street, Newark 5, N. J. Canadian affiliate, Canadian Chemical Company, Limited, Montreal, Toronto and Vancouver.

*Reg. U. S. Pat. Off.

Celanese* PLASTICS

Typical Physical Properties of Forticel

Flow temperature	(°C.) (A.S.T.M.)	D569-48	167—178
Specific gravity		D176-42T	1.18—1.21
Tensile properties:	Yield (p.s.i.)	D638-52T	3380—5020
	Break (p.s.i.)	D638-52T	3470—5240
	Elongation (%)	D638-52T	56—66
Flexural properties:	Flexural strength (p.s.i. at break)	D790-49T	6400—8500
	Flexural modulus (10^5 p.s.i.)	D790-49T	0.23—0.30
Rockwell Hardness:	(R scale)	D785-51	62—94
Izod Impact	(ft. lb./in. notch)	D256-43T	2.7—11.0
Heat distortion	(°C.)	D648-45T	59—70
Water absorption—	% Sol. lost	D570-42	0.00—0.08
	% Moisture gain	D570-42	1.5—1.8
	% Water absorption	D570-42	1.6—1.8

...and to prove it – CAMPCO offers you a sample sheet absolutely free!

Campco S-540 is a new rubber-modified styrene sheet that's plenty tough for most high-impact applications. *Yet, it's priced low—in .080" gauge it costs only about a quarter a square foot!*

But don't take our word for its remarkable toughness – get your sample and test it right in your own shop. And, remember its low, low cost – ⅓ less than competitive sheet of really high-impact resistance.

S-540 cuts costs on high-impact applications. Toys • displays • covers • refrigerator parts • racks • trays • equipment housings • boxes • drawers • hundreds of similar parts and products. Its toughness in thin gauges, coupled with non-toxicity, makes it an excellent packaging material.

S-540 offers all these shop advantages. Can be vacuum-formed with low-cost molds • easy to print on, presents no registration problems • takes naturally to painting or printing • offered in matte, polished or high gloss GM finish, in a wide range of colors, thicknesses and dimensions • attractive porcelainlike finish improves product appearance.

S-540 has properties of high-priced sheet. Has low specific gravity • low moisture absorption • excellent tensile and flexural strength • excellent stability and non-toxicity.

CAMPCO Division of
Chicago Molded Products Corporation

2726 Normandy Avenue
Chicago 35, Illinois

☐ Kindly send me a sample of S-540 in the width and gauge I've indicated below.

Gauge_____ Width_____

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Write for your sample, now — and compare S-540 with the styrene sheet you're now using!

CAMPCO DIVISION OF CHICAGO MOLDED PRODUCTS CORP.

2726 Normandy Avenue
Chicago 35, Illinois

ternal magnet meter movements, or shallow or deep core magnet meter movements.

Instruments can be supplied with sensitivities as low as 10 microamp. All practical ranges can be supplied. Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

For more information—
Circle 68, inside back cover

Tubular Paper Capacitors

This capacitor was designed to meet the demands of general purpose, severe service applications where high temperature operation, high stability and small size are required. It operates over a temperature range of −55 C to 100 C at full-rated voltage. Average capacitance-temperature variation is only 5 per cent from the 25 C value. Insulation resistance at 25 C exceeds 4000 megohm-mfd, with power factor less than 1 per cent. The new capacitor is available in 100, 200, 400, 600 and 1000 v, dc, and capacitances from 0.001 to 1.0 mfd, depending on voltage. Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

For more information—
Circle 69, inside back cover

Capacitors For High Temperature

Teflon-cased capacitors are rated at 450 v, dc, for continuous operation at 125 C. Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y.

For more information—
Circle 70, inside back cover

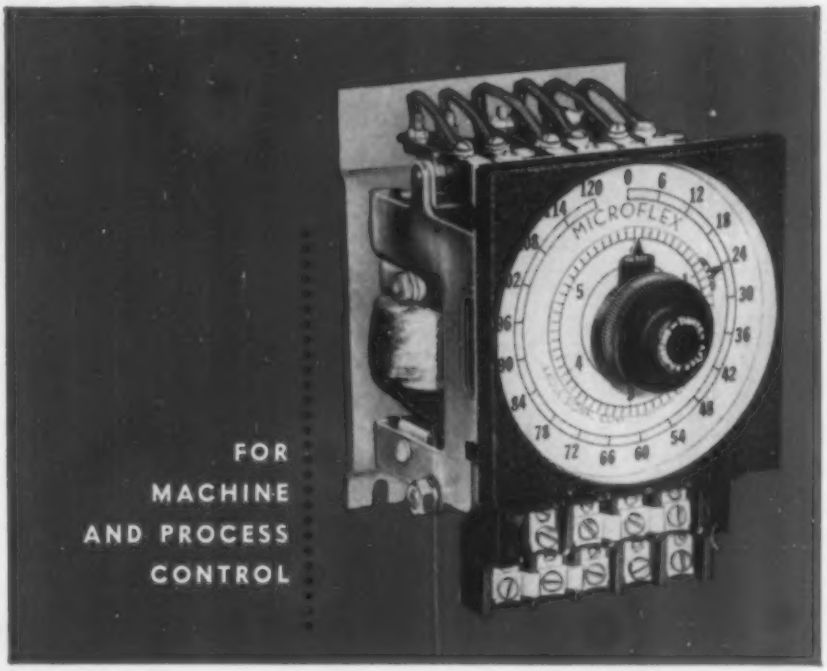
Miniature and Subminiature Capacitors

These miniatures and subminiatures are available in all capacities from 0.1 mmf to 500 mfd, and in capacity tolerances from 0.1 to 20 per cent. Units are furnished in voltages from 3 to 1000 v. Operating temperature ranges are available as specified, from −65 C to 200 C, without derating.

Units can be supplied cased or uncased, flat or round. Leads can be positioned radially, axially, for plug-in or in any other required position. Leads in all types are plastic anchored,

(Continued on page 292)

EAGLE
Microflex Reset Timer



Insures "20-to-1 ratio" accuracy

Time settings of pinpoint accuracy are a reality, thanks to the Microflex double dial. It takes one complete turn of the *inner* dial to advance the *outer* dial just one division. That's a 20-to-1 ratio, made possible by the patented Microflex threaded axle and pinion (see sketch). Examples of resultant accuracies are ± 1/60 of a second on a 20-second dial, and ± 1/10 of a second on a 120-second dial.

The Microflex Reset Timer is driven by a heavy-duty industrial synchronous motor. Contacts are tripped closed or open after a preset time interval. Starting and resetting are electrically controlled. Microflex offers over 150 timer operating combinations, plus a wide range of long or short time periods. It's ideal for applications like molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for free Automation Booklet and Bulletin 110.

MAIL COUPON TODAY

EAGLE TIMERS SAVE TIME . . . SAVE MONEY
EAGLE
SIGNAL CORPORATION
Industrial Timers Division
MOLINE, ILLINOIS

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. PE-1155
MOLINE, ILLINOIS

Please send free Automation Booklet and Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE _____
COMPANY _____
ADDRESS _____
CITY ZONE STATE

Cold flow resistance of TEFLON* and reinforced TEFLON (DUROID 5600) was tested at 700° F., under a torque of 35 pounds and a flange pressure of 1,000 p.s.i. After 2 hours the flanges were cooled and the bolts retightened. The flanges were then exposed to the heat for another 2 hours. Results are as pictured. The gasket of TEFLON (left) extruded extensively on all edges and lost all bolt torque. DUROID 5600 did not extrude and retained 15 pounds bolt torque, demonstrating significantly improved resistance to cold flow.

Greater Resistance to Heat Distortion

TEFLON (left) distorted badly when subjected to 720° F. and then cooled. Reinforced TEFLON (DUROID 5600) exposed simultaneously to the same temperature retained flatness, demonstrating greater dimensional stability at high temperatures.

SOME IMPORTANT TEST VALUES

Tensile Strength, MD, psi	2500
Tensile Strength, CMD, psi	1500
Compressibility, 5000 psi, %	8
Thermal Expansion Coefficient per °F., 73-140°F.	2.7×10^{-5}
Heat Distortion Temperature, °F.	
66 psi	500+
264 psi	500+
Deformation under Load, %	
1200 psi	2*
2000 psi	3*
Coefficient of friction against polished steel,	
static	.21
kinetic	.14
Specific Gravity	1.90

*Made up of actual flow and also of compression under load. Data to indicate breakdown between these two portions is being obtained.

ROGERS REINFORCES "TEFLON" TO REDUCE ITS COLD FLOW

Rogers DUROID 5600 is a combination of TEFLON and inert fibers, blended into an homogeneous sheet material. This new material is not a replacement or a substitute for TEFLON, but rather an extension of it. TEFLON has better electrical characteristics and dry lubricating qualities. DUROID 5600, however, has much of TEFLON'S resistance to chemicals, and is greatly superior to TEFLON in resistance to cold flow and heat distortion.

*Registered trademark of DuPont Company for its tetrafluoroethylene resin.

Please write
Dept. E
for Technical Bulletin

ROGERS CORPORATION

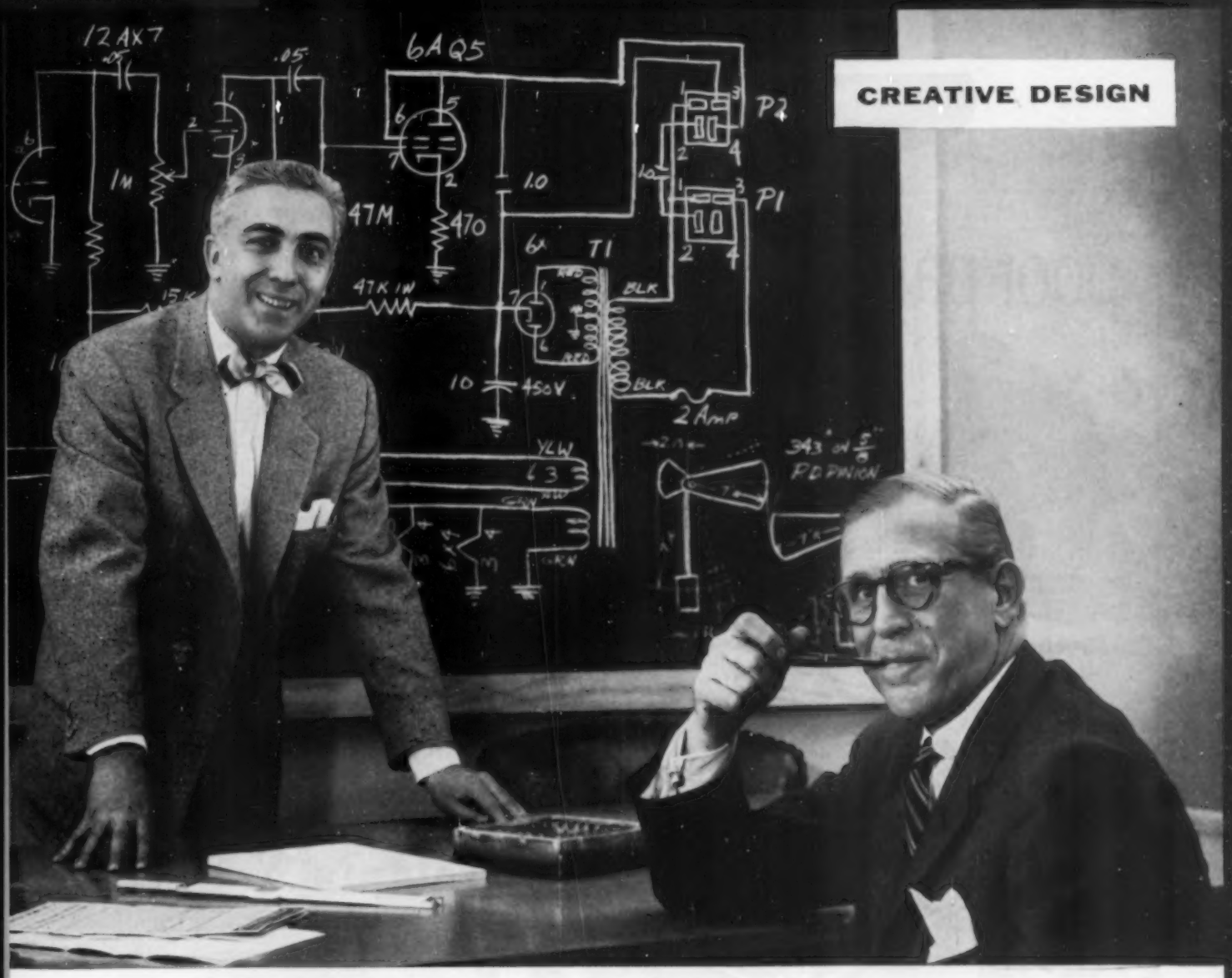
ROGERS, CONNECTICUT

PRODUCTS

DUROIDS—for Gaskets, Filters, Electronic Devices, etc.
SHOE MATERIALS—for Counters, Midsoles, Liners, etc.
ELECTRICAL INSULATION—for Motors, Transformers, Generators, etc.
PLASTICS—Special Purpose Molding Compounds and Laminates.

SERVICES

FABRICATING—including Combining, Coating, and Embossing.
DEVELOPMENT—Research and Engineering of New Materials, Parts, and Products.



They wanted to change pounds to volts

After a hundred and twenty-five years of scale engineering it was easy!

Fairbanks-Morse Scale Engineers sought and found the practical way to adapt modern electronic principles to one of man's oldest commercial activities—the accurate weighing of items of trade.

The result is the new Fairbanks-Morse Electronic Scale that brings weighing information right to your desk from any spot that is too remote, too hot or too dangerous.

Only from Fairbanks-Morse can you get such originality and soundness of *new* design that assures outstanding performance. When next you need a scale . . . or a pump . . . an electric motor . . . or a diesel engine, look for the famous F-M Seal. For 125 years it has stood for the finest in practical engineering. Fairbanks, Morse & Co., Chicago 5, Illinois.

The Secret is this desk-sized electronic instrument that is direct reading; direct indicating—no manual switching or mental additions. Memory circuit prevents printing unless true balance exists.

The Result is that indications can be brought from remote locations to a central spot and integrated into other automatic electronic operations for faster, more complete utilization of weighing information.

FAIRBANKS-MORSE

a name worth remembering when you want the best

SCALES • PUMPS • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MOWERS • MAGNETOS

poor paint adhesion?

FREE MANUAL
shows how phosphating will solve your problems!

If poor paint adhesion is your problem, chances are you'll find the solution in the Turcoat Phosphating Manual. This booklet describes the complete Turcoat line, tells the full story of phosphating and includes a valuable "Phosphating Reference Chart," which quickly gives the answer to any paint adhesion problem.

If you are interested in permanent paint adhesion, write today for the Turcoat Manual. There is no cost or obligation.

Offices in all principal cities

TURCO

TURCO PRODUCTS, INC.
Chemical Processing Compounds
6135 So. Central Ave., Los Angeles 1, Calif.
Factories: Newark, Chicago, Houston, Los Angeles

You will be assured of a *permanent paint seal*, simply by using Turcoat as a bond for organic finishing.

Please affix coupon to company letterhead
TURCO PRODUCTS, INC.
6135 So. Central Ave., Los Angeles 1, Calif.
Please send me a copy of the Turcoat Manual without cost or obligation.

Name_____

Title_____ PE

and cannot be pulled out. Capacitors can be supplied in steatite, bakelite, plastic-treated paper, or in metal tubes, in cans, or can be supplied plastic encapsulated, dipped or molded. Write to Capcon, Inc., 25 Willett St., New York 2, N. Y.

For more information—
Circle 71, inside back cover

Flat Capacitors

These sub-miniature components can be used with printed circuits and automatic assembly processes. All sizes are supplied with two sets of parallel leads. These capacitors are made of Mylar polyester film dielectric material and are encapsulated in high quality Kel-F. This construction provides a moisture seal, and stable operating characteristics over a wide temperature range.

Standard sizes are rated at 150 and 250 v, dc, at 125 C. For use at 85 C and below, these ratings are increased to 250 and 350 v, dc, respectively. Sanders Associates, Inc., Nashua, N. H.

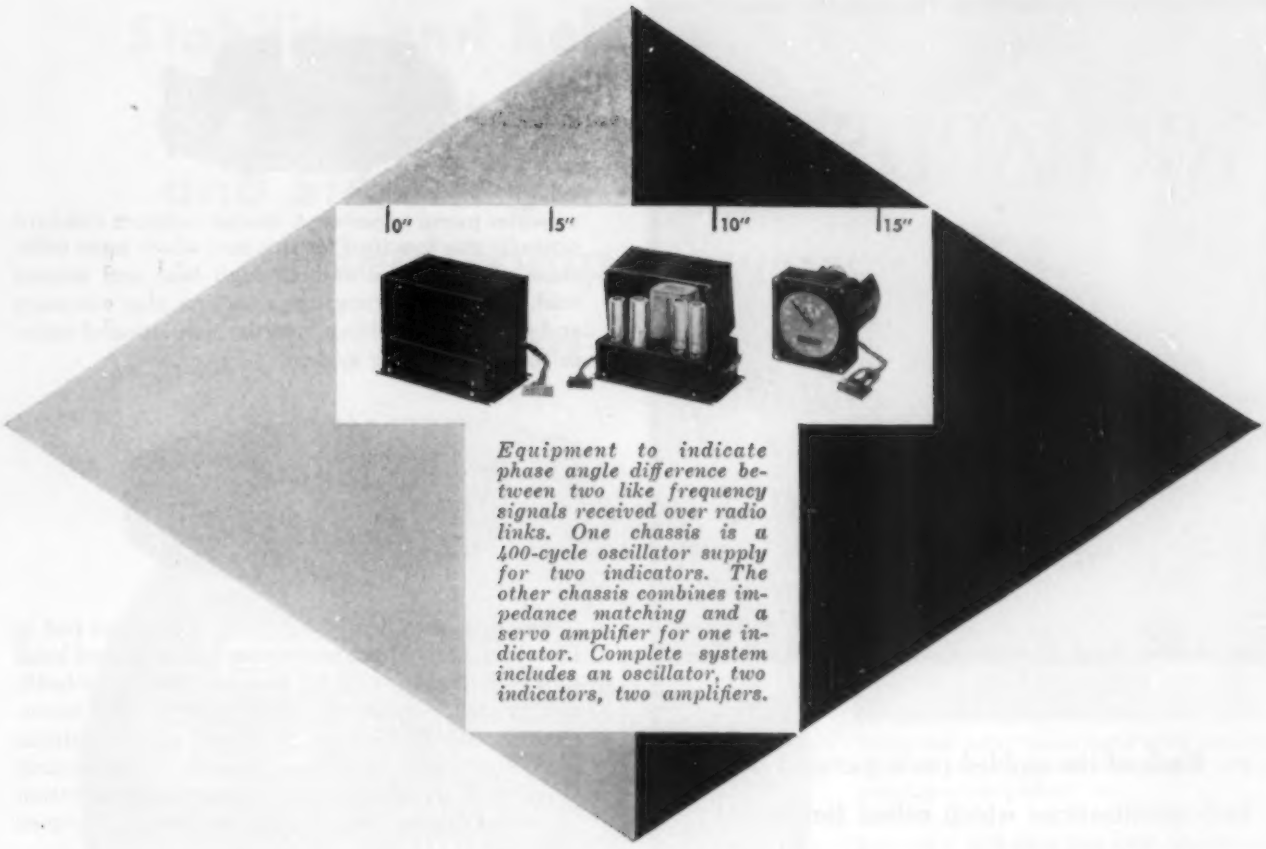
For more information—
Circle 72, inside back cover

Spring-Actuated Slip Sockets

Solderless connecting of diodes, transistors and other components into a circuit, particularly printed circuits and subminiature assemblies is possible with the spring-backed, plug-in socket made of copper alloy. Its outer shell is approximately 0.2 x 0.08 in. dia. It is press-fitted and dip-soldered into the circuit board.

The diameter of the socket is such

(Continued on page 296)



Equipment to indicate phase angle difference between two like frequency signals received over radio links. One chassis is a 400-cycle oscillator supply for two indicators. The other chassis combines impedance matching and a servo amplifier for one indicator. Complete system includes an oscillator, two indicators, two amplifiers.

servo problems stock units can't solve

This equipment "does the job right" because it was especially designed for a single application . . . by a company whose major function is solving individual servo control problems with complete, precisely engineered and manufactured servo assemblies.

Of course, if you just want servo *components*, Transicoil can provide them to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

Check out your next servo problem with Transicoil first. Ask for the new gear-motor availability guide if you haven't yet received a copy.

Transicoil

CORPORATION

Worcester • Montgomery County • Pennsylvania

RICHARDSON

helps improve molded auto parts

Each of the molded parts pictured here had specifications which called for special materials often with unusual properties. All called for creative design approaches, both by customer and Richardson.

Richardson engineers, specialists in both molded and laminated plastics, will welcome the opportunity to help you. Write or phone for additional information.

THE RICHARDSON COMPANY
FOUNDED 1858
2793 Lake St., Melrose Park, Ill. (Chicago District)

MELROSE PARK, Ill.

INDIANAPOLIS, IND.

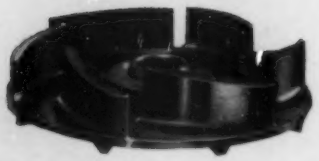
NEWNAN, GA.

OGDEN, UTAH

SALES OFFICES IN PRINCIPAL CITIES

NEW BRUNSWICK N. J.

TYLER, TEXAS



. . water pump impeller A special moisture resistant phenolic was specified for this part which must withstand the extremes of both high heat and intense cold, as well as strong torque action plus corrosion and cavitation resulting from the circulation of water in the car's cooling system.

. . timing gear The molded blank of this gear had to have high flexural characteristics . . also a good bond in the laminate section for ease in cutting gear teeth, and to insure necessary tooth strength. The manufacturer and Richardson developed a new material with high heat resistance. Result: Fine flexural strength in the web section . . more quiet operation . . . easier fabrication . . . easier assembly . . . *tripled gear life!*

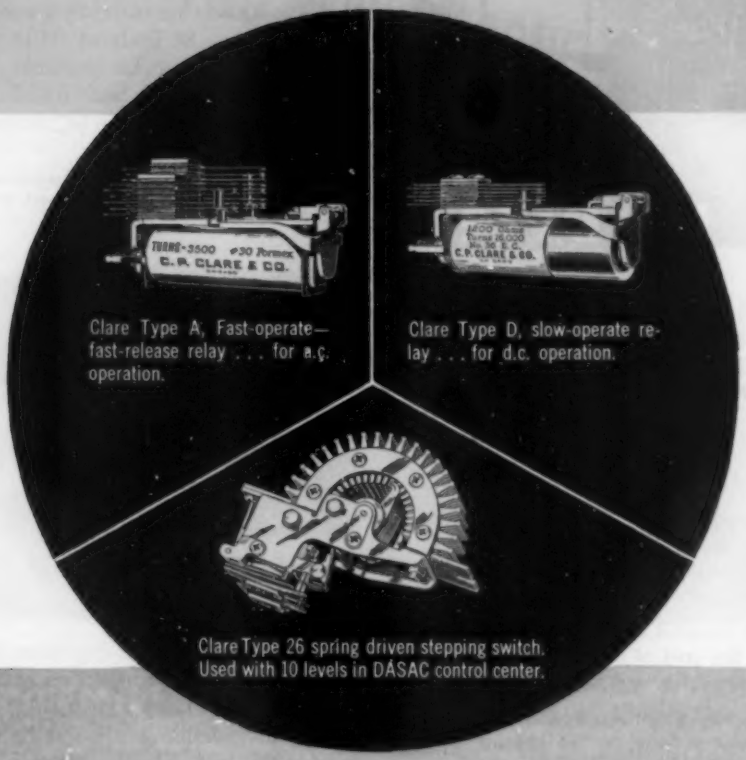
. . radio antenna mast base This part had to have good surface appearance, high impact strength, high dielectric strength, and at the same time be weather resistant. A black phenolic material with an attractive high gloss finish was recommended.

. . dashboard light lens Originally this part was designed as a clear lens. Later, when the specifications were changed to call for a translucent lens, the customer suggested that either the mold, or the clear parts, be sandblasted. . either process would have increased costs. Richardson suggested, instead, a special light-transmitting polystyrene. Result: 15% reduction in lens cost.

RICHARDSON PLASTICS

MOLDED AND LAMINATED

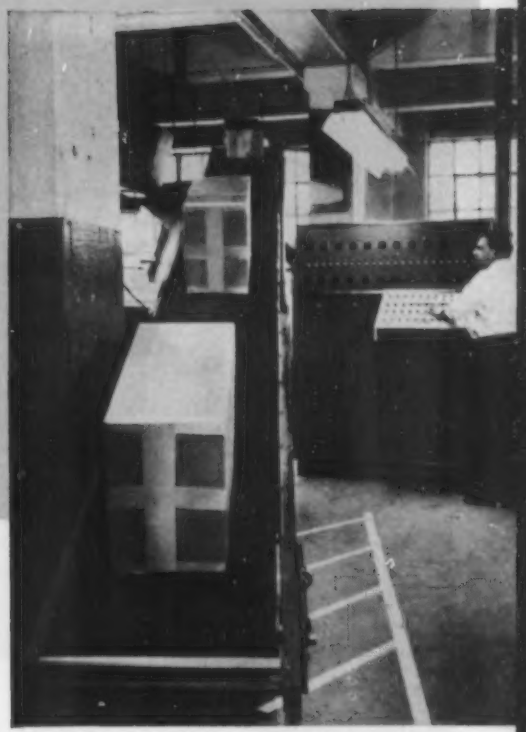
Stability and Reliability make CLARE Relays and Stepping Switches ideal components for DASAC



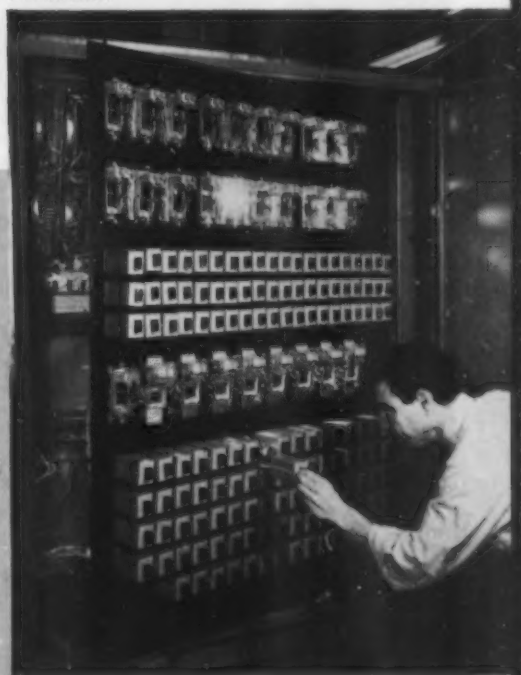
Clare Type A, Fast-operate—fast-release relay . . . for a.c. operation.

Clare Type D, slow-operate relay . . . for d.c. operation.

Clare Type 26 spring driven stepping switch. Used with 10 levels in DASAC control center.



DASAC Push Button Control Center which uses Clare relays and stepping switches in automatic control of warehouse assorting system.



Rear view of panel shows Clare relays, provided with dust tight covers, accessible for quick inspection and maintenance.

Pushbutton control center of the DASAC warehousing and assorting system makes use of over a hundred CLARE Type A and D relays and CLARE 10 level, 26 point stepping switches.

This device, which speeds and simplifies order picking operations, was developed by New York's Dasol Corporation, consulting engineers, to facilitate the warehouse operations of their client, Judy Bond, Inc., large blouse manufacturer.

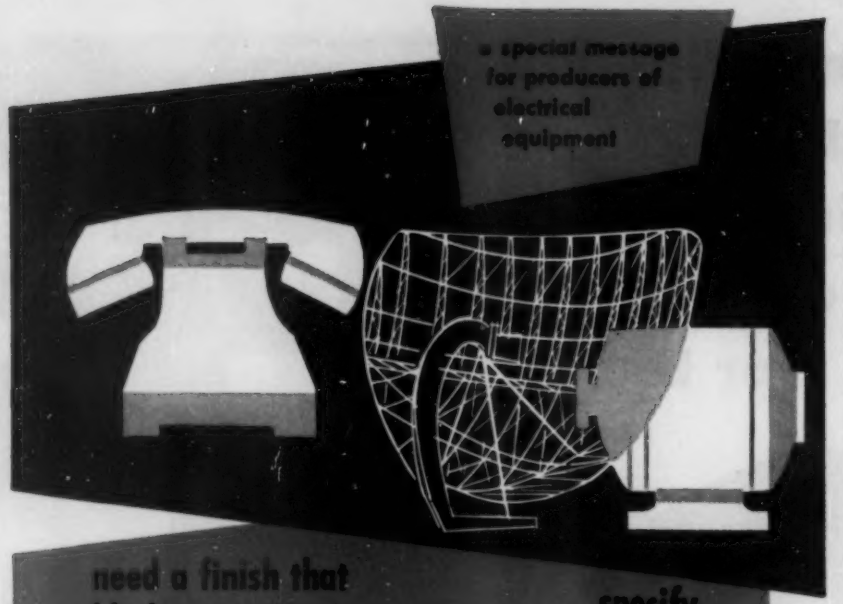
The DASAC Control Center performs three basic functions. These include selection of container destination, "memorizing" the selections in consecutive order and coordinating the information to stop the container at its proper discharge point. "Relay requirements," said Sol Tanne, Dasol Chief Engineer, "above all, demanded stability and reliability. They had to be fast-acting, quiet, stable telephone-type relays which could easily be replaced if necessary."

Ability of CLARE Relays to perform millions—in some cases billions—of trouble-free operations has made them increasingly in demand as reliable components for today's high speed devices. If your design calls for long-life, high-quality relays or stepping switches, it will pay you to bring your problem to CLARE. Experienced field engineers are located near you. Contact them or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

a special message for producers of electrical equipment



need a finish that blocks corrosion, maintains conductivity?

specify IRIDITE®

Here's peak corrosion protection combined with conductivity, weldability and solderability. Here's a finish that holds paint firmly, prevents underfilm corrosion. Here's a line of attractive final finishes to add quality and sales-appeal. Here's Iridite . . . and here's how you can use it:

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, ABP Plating Chemicals.
WEST COAST DIVISION: L. H. Butcher Co.

Electric Power, Control

that the receiving hole in the circuit board can be either punched or drilled. Press-fitting can be done without the use of any special tool. The spring inside the socket is flexible enough to withstand repetitive plug-in-and-out operations, yet strong enough to hold the lead with a retaining force of several ounces. The spring can be designed to cover military specifications on shock and vibration.

These sockets are currently available from stock to fit leads of 0.016 in. dia and will soon be available for lead sizes of 0.175 and 0.022 in. Techron, Inc., 254 Friend St., Boston, Mass.

For more information—
Circle 73, inside back cover

Plug-In Tubular Capacitors

Solid dielectric paper capacitors designed for printed wiring board assemblies have an index key molded in the phenolic housing adjacent to the outside foil lead. This facilitates identification of the lead for automatic insertion by machinery or hand operators. Three stand-off feet raise the endseal and shell above the printed wiring board. Sprague Electric Co., 195 Marshall St., N. Adams, Mass.

For more information—
Circle 74, inside back cover

Resistors for Printed Circuits

These resistors are encapsulated in a tough epoxy compound for protection against humidity, mechanical and thermal shock. The plastic is filled with heat-conducting mineral which is said to dissipate the heat and equalize "hot spots" in winding. Sealed-in terminal connections are welded. They satisfy military requirements of MIL-

(Continued on page 300)

For the first time silicone rubber sheet stocks are available in economical continuous-roll lengths

Du Pont offers these high-grade, general-purpose sheet stocks in two hardnesses—50 and 70 durometer—and three thicknesses—1-32", 1-16" and 1-8".

Silicone rubber sheets are designed to fill the urgent need for gasket materials in high- and low-temperature applications. Flexible and strong, these sheets are resistant to temperature extremes, oil and abrasion . . . exhibit excellent anti-stick properties.

The unique properties of these new stocks may be just what you need to make a new design a success—or to improve an old one. The continuous-roll feature means more efficiency and economy, too. Why not have a Du Pont representative call on you to discuss possible applications of silicone rubber sheets? He'll be glad to be of service. Just clip and mail coupon for further information.

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, P-511, Fairfield, Conn.

I am interested in "Fairprene" Industrial Products.

( ) Have a representative call. ( ) Send further information on silicone sheet stocks.

Name_____ Title_____

Firm_____

Address_____

City_____ State_____

DU PONT INDUSTRIAL COATED FABRICS

COATINGS OF

Silicone rubber • Neoprene • Buna N • GR-S

ON THESE FABRICS

Nylon • "Dacron"† • Glass
Cotton • "Orlon"‡ • Asbestos

Glass fabrics coated with "Teflon" tetrafluoroethylene resin, elastomer sheet stocks and cements

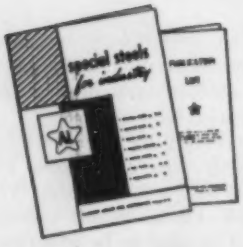
†Du Pont's trade-mark for its polyester fiber.
‡Du Pont's trade-mark for its acrylic fiber.

E. I. du Pont de Nemours & Company (Inc.)
Fairfield, Conn.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Dollars of ***FIRST COST*** *aren't so big . . . if they're the* ***LAST COST***



WRITE TODAY
For These Publications

1. SPECIAL STEELS FOR INDUSTRY . . . 16 pages of essential data on the proper selection and application of principal AL special alloy products: stainless, tool and electrical steels and sintered carbides.

2. PUBLICATION LIST . . . a complete listing of all AL publications, both technical and nontechnical (over 100 in all), with a handy order form for your convenience.

ADDRESS DEPT. PE-71

First cost isn't everything! What really counts in most cases is not how much a thing costs when new, but how long it lasts; how *little* it actually costs when reckoned in terms of extra years of service.

That is where AL Stainless jumps to the head of the class. Stainless steel is a package of built-in advantages you just can't match anywhere else. No other commercial material is at once as hard, strong and lastingly beautiful — as resistant to heat, wear and corrosion — as easy and inexpensive to clean and maintain.

To top it off, AL Stainless is easy to fabricate, and we produce it in every shape or form a fabricator may require. Check up on its money-making possibilities for *you*, either in your products or your equipment, *and let us help!* ● ***Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.***

WAD 5483 B

Make it BETTER-and LONGER LASTING-with

AL Stainless Steel

AL ALLEGHENY LUDLUM ®

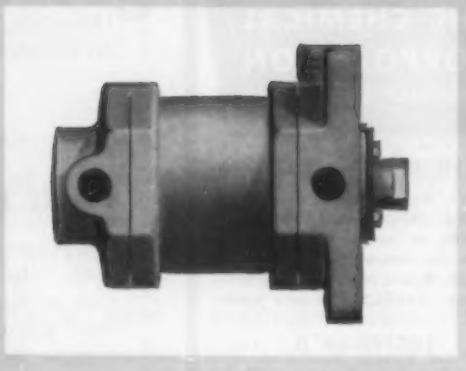
Warehouse stocks carried by all Ryerson Steel plants

Why choose a Rivett Hydraulic Cylinder?

Quick Delivery?

YES!

If you're in a tight spot and need standard models, Rivett can ship in two days.



Low Price?

YES!

You'll make the best deal with Rivett. Large volume production makes prices competitive!

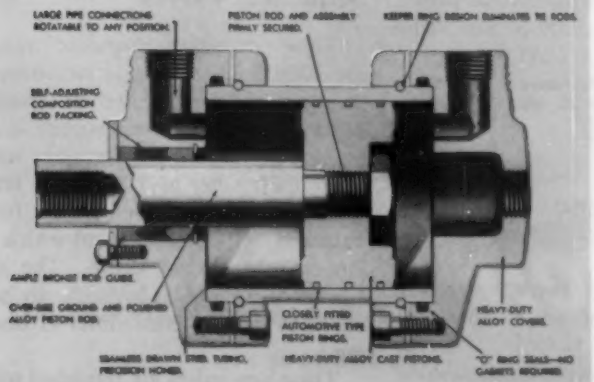
High Quality?

YES!

This is the most important reason for choosing Rivett! After a cylinder is installed, delivery and price are soon forgotten—but not the cylinder's productivity! It is then that a poor cylinder reveals its really high cost. For its faulty construction can result in operational failure—with a breakdown in production.

Better—far better, to buy the quality cylinder; gain the advantages of delivery and price; and enjoy uninterrupted production as well!

THE BETTER YOU KNOW HYDRAULICS, THE BETTER YOU LIKE RIVETT!


LARGE PIPE CONNECTIONS ROTATABLE TO ANY POSITION
PISTON ROD AND ASSEMBLY FINALLY SECURED
KEEPER RING DESIGN ELIMINATES TIE RODS
SELF-ADJUSTING COMPOSITION ROD PACKING
AMPLE BRONZE ROD GUIDE
CHROME-SIZE GROUND AND POLISHED ALLOY PISTON ROD
CLOSELY FITTED AUTOMOTIVE TYPE PISTON RINGS
HEAVY-DUTY ALLOY COVERS
HEAVY-DUTY ALLOY CAST PISTONS
"O" RING SEALS—NO GASKETS REQUIRED

Get This Data-Filled Catalog →

Working drawings, cut-aways, tables, diagrams, forces, specifications—all are presented in an easy-to-use style. Write today for free copy of Catalog No. 106.

RIVETT LATHE & GRINDER, Inc.
Dept. PE 11, Brighton 35, Boston, Mass.

Representatives In All Principal Cities

Member—National Fluid Power Association

RIVETT

furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

more important
NEW DEVELOPMENTS
from
THE CHEMICAL CORPORATION
Research Laboratory

LUSTER-ON® OLIVE DRAB N. D.
A dark, hard, stable olive drab coating. Applied in about 15 seconds at room temperature. Gives maximum corrosion protection. Meets most rigid specifications. Available in one package.

LUSTER-ON D
A powdered product to produce a bright clear conversion coating on zinc and cadmium.

LUSTER-ON ACTIVATOR
Designed for preparing a zinc alloy die casting prior to treatment in our Luster-On acid baths. Also serves as a mild cleaner. However, heavy soil must be handled by a precleaner.

LUSTER-ON NS
The answer to "spotting out" troubles on thin copper and brass plate, especially under humid conditions. Improves adhesion, provides leveling action, saves lacquer. Eliminates fingerprints before assembly.

LUSTER-ON ALUMINUM SEALER (222-M)
Produces a chromate film on aluminum that provides excellent corrosion protection and can serve as a paint base. Now can be dyed in many attractive pastel colors. Meets requirements of Government Spec. MIL-C-5541.

Ask for literature. Send a sample for free laboratory treatment.

Luster-On products are manufactured on the West Coast by Crown Chemical and Engineering Company of Los Angeles, Calif., and in the Dominion of Canada by Alloycraft Limited of Montreal, Quebec.

You'll also be interested in our SafetyDivision's line of industrial skin cleaners and protectors . . . protect your workers and your products. Literature available.

L-18

THE Chemical CORPORATION
59 WALTHAM AVENUE
SPRINGFIELD, MASS.

R-93A and JAN-R-93. Temperature coefficient: ±0.0022 per cent per degree C; operating temperature: −65 C to 125C. Wattage range is from 0.25 to 1 w with tolerances to 0.1 per cent. Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.

For more information—Circle 75, inside back cover

Plastic Film Capacitors

Operating temperature range is −65 C to 165 C. Minimum insulation resistance measured with an applied potential of 100 v and an electrification time of 2 min is 75,000 megohm-mfd, min. Capacitors are built to withstand a d-c voltage equal to 200 per cent of the rated voltage for 1 min at 25 C. Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

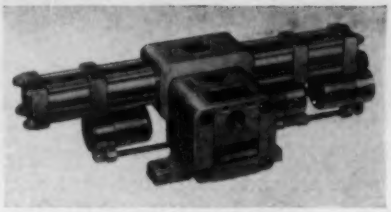
For more information—Circle 76, inside back cover

Card-Type Precision Resistor

This resistor is wafer-thin and is specifically designed for applications where there is a lack of space for the round wire-wound resistor. The new unit is completely encapsulated for protection against humidity, salt-water immersion, extremes of temperature and is especially adaptable for circuits using transistors. On values up to 100,000 ohm, the new Series 1300 single-section resistor is ½ x ½ x 1/32 in. thick. On values from 100,000 ohm to one megohm, the card is ⅝ x ⅝ x 1/32 in. thick. Operating characteristics feature precise operation from 55 C to 125 C. Wattage rating on each section is 0.6 w and standard tolerance is ±1.0 per cent. Daven Electronic Sales Corp., 191 Central Ave., Newark 4, N. J.

For more information—Circle 77, inside back cover

FLUID POWER AND CONTROL



Power-Operated Valve

Power operation to forward, reverse and neutral is provided by this four-way disc valve for air, gas, oil or water service, controlled by a three-position power attachment operated by air or gas. The molybdenum alloyed semi-steel body is chrome-plated. Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles 15, Calif.

For more information—Circle 78, inside back cover

General Purpose Solenoid Valve

All parts of this two-way valve in contact with fluid are of brass or stainless steel. A slotted "V" type disc provides tight seating and cushion closing on liquids. UL-approved and listed, these new valves are suitable for class I, group D and class II, groups E, F, and G hazardous locations.

Normally open or normally closed construction can be supplied when required. The valves are available in sizes from 1¼ to 3 in. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

For more information—Circle 79, inside back cover

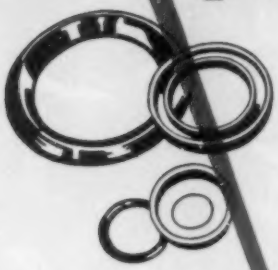
Low Leakage Sequence Valves

These slide-type sequence valves for 3000 psi hydraulic service have a standard maximum internal leakage of 15 drops per minute. Special models are available with maximum leakage values as low as 5 drops per minute. Valves are designed with a fully balanced, self-cleaning spool which is lapped into a rigid sleeve. The entire spool assembly is hydraulically balanced to prevent possibilities of binding.

These new valves are furnished with

(Continued on page 304)

how to pick the right packing



To be sure that you get the *right* packing for *your* installation—put the problem up to Houghton's hydraulic engineers. They are backed by over 50 years' experience in hydraulics, and can give you sound answers.

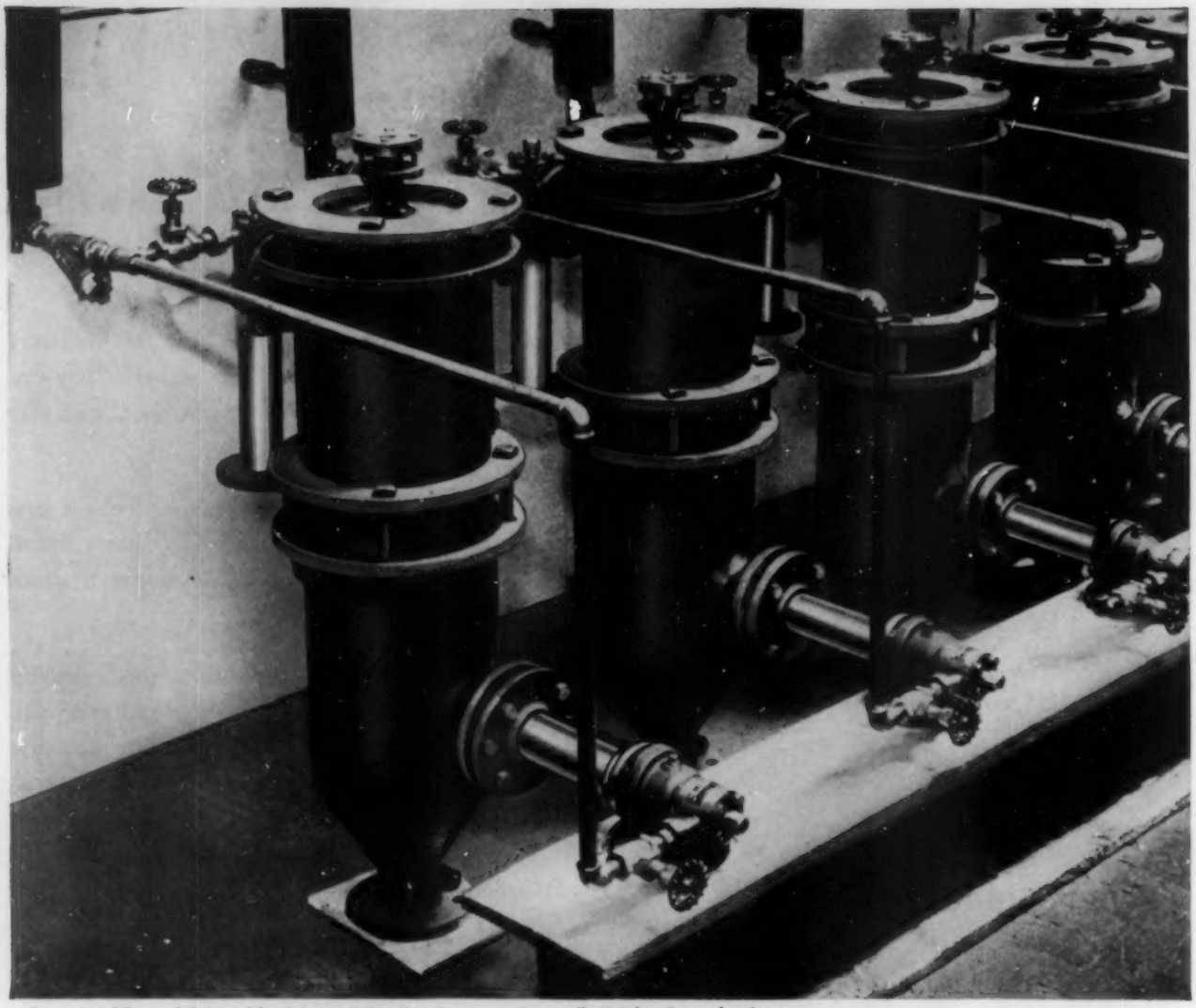
Houghton makes all types of packings—rubber, rubber and fabric, rubber and leather, and leather. They know which type and style of packing will work best under a given set of conditions.

Call your Houghton Man and go over your packing problem in detail with him. The resources and hydraulic know-how of the entire Houghton organization are at his command to give you the right answer—and it costs you nothing. Call him or write today. E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

VIM and VIX-SYN PACKINGS
. . . products of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . .



Steam jet diffusers fabricated by Schutte & Koerting Company, Cornwells Heights, Pennsylvania.

TITANIUM cuts replacements 90%

These "steam jet diffusers" create a process vacuum in a large scale chemical operation. And they used to be replaced every three months.

High-velocity steam and dilute hydrochloric acid formed a natural environment for cavitation corrosion and erosion—quick death for the cast iron diffusers originally used. Several alternate corrosion-resisting materials were tried, without success, until REM-CRU titanium was specified.

The first titanium diffusers were placed in service 2½ years ago. They are still going strong, with no sign whatever of corrosion or erosion—*a 1000% improvement in service life, and more to go.*

Titanium's remarkable properties explain why such improvements are possible. First, titanium is immune to attack by chlorides—and an unusually wide spectrum of other corrosives. Furthermore, it resists erosion by high-velocity fluids—and abrasion, shock and fatigue stresses. It is as strong as steel, at about half the weight, which means significant reduction in volume—and cost—of material required.

Investigate REM-CRU titanium for yourself whenever you find too-frequent metal failures under corrosive conditions. Remember, it is available in all sizes and grades—and in substantial quantities at the lowest prices ever, thanks to REM-CRU's expanded facilities and recent price reductions. So find out more about titanium—call in a REM-CRU engineer today.

To keep abreast of the latest developments on this vital metal, write to Dept. P-11 for the Rem-Cru Review—a free periodical presenting the latest technical data on titanium alloys.

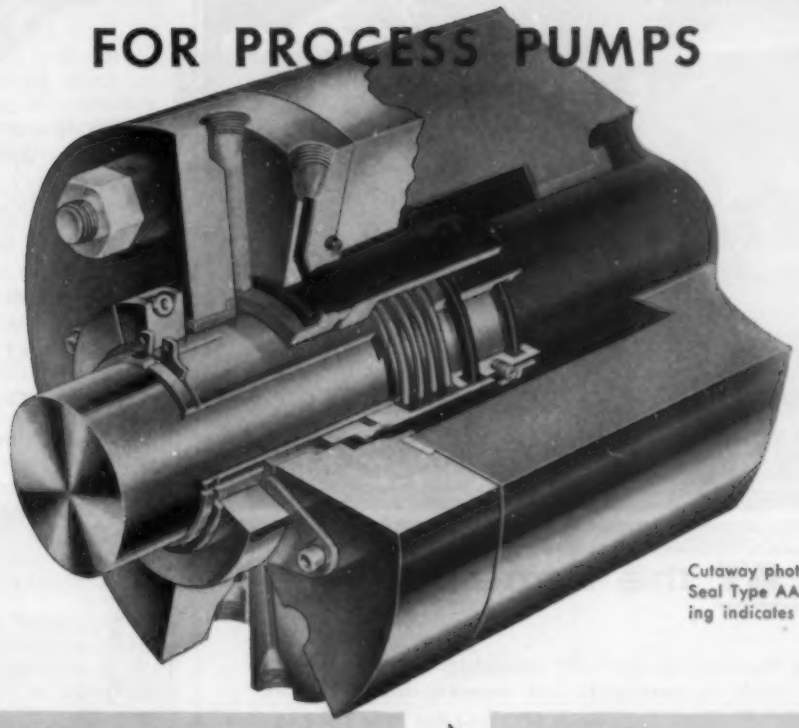
REM-CRU TITANIUM

REM-CRU TITANIUM, INC., MIDLAND, PENNSYLVANIA

NEW from GARLOCK...

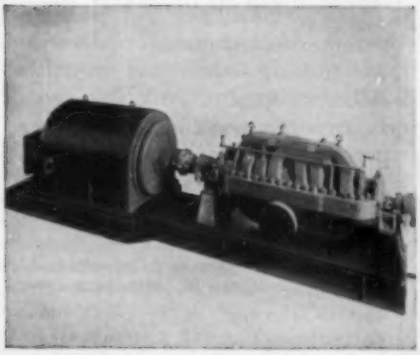
MECHANIPAK* SEALS

FOR PROCESS PUMPS



Cutaway photo of Garlock Unitary Seal Type AA51B-23. Yellow shading indicates liquid being sealed.

- One Piece Assembly
- Quick, easy installation
- Pre-set at factory
- Maintenance-free life



Typical boiler feed pump for which Garlock Unitary Seals are designed.

SAVE installation time, eliminate maintenance costs with Garlock's new Unitary Mechanipak Seals for process pumps!

The entire unit, including sleeve and gland, is furnished completely assembled. The seal is pre-set at the factory—no on-the-job adjustments are needed. The *external* lock and drive is readily accessible—eliminates set-screw drive.

Get all the facts today! Phone your Garlock representative or write for new Folder AD-151.

The Garlock Packing Company, Palmyra, New York

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N. Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK

*Registered Trademark

LOOK HOW

Linde silicones make water behave itself!

LOOK AT the benefits

Guarding many thousands of cars today against rain, snow, and dirt, are auto polishes made easier-to-apply and longer-lasting by LINDE Silicones.

Silicones give milady a helping hand, too . . . in her hand lotions, for example. They help ward off soapy dish water and detergents. Her suntan preparations stay on even after a swim in the deep.

And of growing importance are above-grade masonry water repellents made with LINDE Silicones that hate water. These "invisible raincoats" are protecting homes, schools, institutions, factories, against damage from water seepage for as much as ten years. They slash both interior and exterior maintenance costs, and preserve original building beauty and quality.

If you want a silicone that will make water "behave," or for some totally different use in your products, call on LINDE. Their wide experience and that of other Divisions of UNION CARBIDE puts a large store of industrial knowledge at your service. Write Dept. P-11.

LOOK TO Linde for silicones

Linde AIR PRODUCTS COMPANY | A DIVISION OF UNION CARBIDE AND CARBON CORPORATION

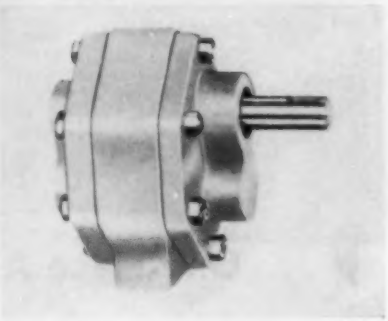
30 East 42nd Street UCC New York 17, N. Y.

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited

The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corporation.

AND-10050-4 or −6 ports for ¼ or ⅜ in. tube sizes; operate at ambient temperature ranges from −65 F to 275 F. They are provided with either full flow by-pass or thermal type auxiliary relief valves for use at cracking pressures ranging from 8 to 4000 psi. Aircraft Products Co., 300 Church Road, Bridgeport, Pa.

For more information— Circle 80, inside back cover



Hydraulic Pumps

Rated for 1000 psi continuous duty, these pumps are made in five sizes, with discharge capacities from 8 up to 22 gpm. They are available in a variety of flanges, mountings and portings. Used on truck-mounted equipment, road building machinery, materials handling equipment, automotive products, farm machinery and many other types of equipment both mobile and stationary. Wisconsin Hydraulics, Inc., 3165 N. 30 St., Milwaukee 16, Wis.

For more information— Circle 81, inside back cover

Cushioned Air Motor

A 2½ in. bore air motor with adjustable cushioning at either or both ends has a built-in, four-way valve. These

(Continued on page 308)

HOWELL MOTOR BRIEFS

Quick facts for those who design-in and specify electric motors

Gearmotors — speed . . . *and cost* . . . reducers!

Where driven speeds less than normal motor speeds are required, there are good reasons for using a gearmotor as opposed to a motor-plus-reducer-plus-coupling arrangement. Here are some of them:

1. **LOWER FIRST COST** is a big advantage—see table in adjoining columns for some specific comparisons.
2. **COMPACTNESS** that can give you significant space savings — plus a *better looking* drive.
3. **STANDARDIZATION** — fewer parts for you and your customers to stock. NEMA-standard gearmotors, like Howell's, are completely interchangeable — Howell ships them from stock.
4. **GREATER RELIABILITY** — With one integral unit and direct coupling, chances for wear and failure are greatly reduced.

Gear Hardness Counts

The degree of compactness and reliability you get in a gearmotor is dependent in good measure upon the hardness of the gears. Howell's parallel shaft units have gears machined to close tolerances from steel substantially harder (Rockwell 52-60) than is average in the industry. Result — a smaller gear package with superior wear resistance. Howell right angle units have precision ground steel worms integral with shaft, and worm gears made of high grade alloy bronze.

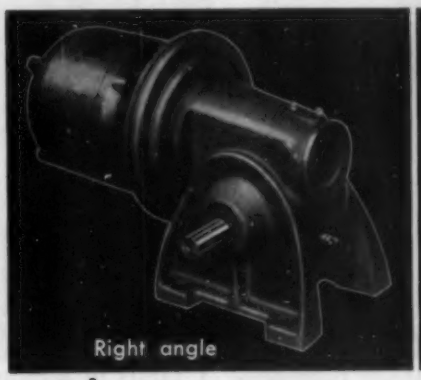
The right angle type of gearmotor is a recent addition to the Howell Motor line and complements the parallel shaft series. A Howell sales engineer will be glad to show you which is best for your application.

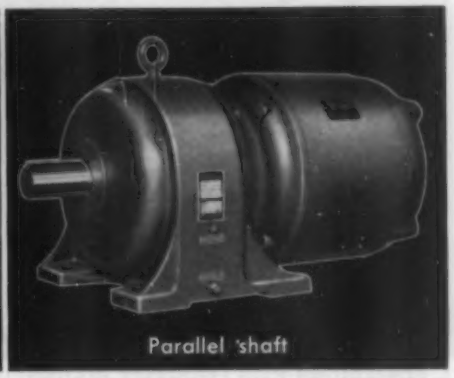
Note This Versatility

Howell is one of the few manufacturers to offer gearmotors with the motor of any electrical or mechanical type. Electrical types available include elevator and hoist, slip ring, torque and multi-speed motors.

Mechanically, they can be supplied in various types of enclosures — either with feet or with flanges for mounting horizontally or vertically. Optional accessory equipment includes brakes and zero speed switches.

Howell Gearmotor Capacities:
Parallel Shaft: 1 to 150 hp
Right Angle Shaft: ⅛ to 40 hp


Right angle


Parallel shaft

***savings*— Howell Gearmotors vs. Separate Motor, Reducer, Coupling and Base — based on open motor and Class I gears**

I. Ratio 11.4 to 1 or 155 RPM with 1750 Motor

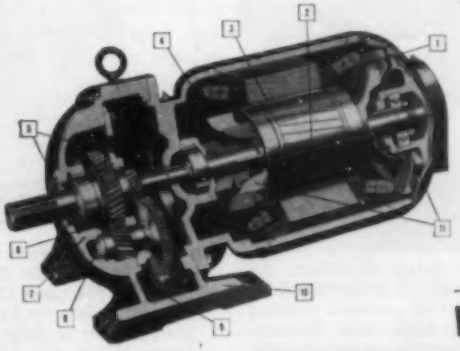
HORSEPOWER	GEARMOTOR SIZE	REDUCER SIZE	GEARMOTOR SAVINGS*
1	21A-203	21-SL	$106.76
1½	21A-204	21-SL	82.38
2	21A-224	21-SL	60.12
3	21A-225	21-SL	28.32
5	21A-254	22-SL	35.52
7½	23A-284	23-SL	101.10
10	23A-324	23-SL	52.70

II. Ratio 86.5 to 1 or 20 RPM with 1750 Motor

1	32A-203	32-SL	$ 71.30
1½	33A-204	33-SL	134.08
2	33A-224	33-SL	78.96
3	34A-225	34-SL	154.42
5	34A-254	34-SL	43.06
7½	35A-284	35-SL	236.80
10	35A-324	35-SL	111.40

*Complete cost breakdown furnished on request

11 reasons why Howell Gearmotors last longer, serve you better



1. High-quality insulation
2. Copper-clad rotor
3. Expert Craftsmanship
4. High-quality coil varnish
5. Leakproof oil seals
6. Duti-Rated Lifetime Gearing
7. Unit case construction with integral bearing housings
8. Corner-mounted offset shaft
9. Large oil reservoir
10. Heavy, cast-iron construction
11. Superior cooling

Write for Bulletin GM-1

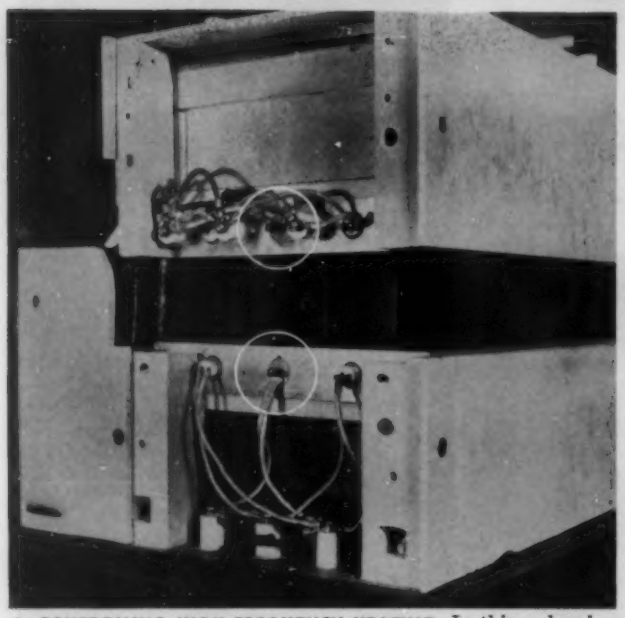
HOWELL Red Band MOTORS

HOWELL MOTORS

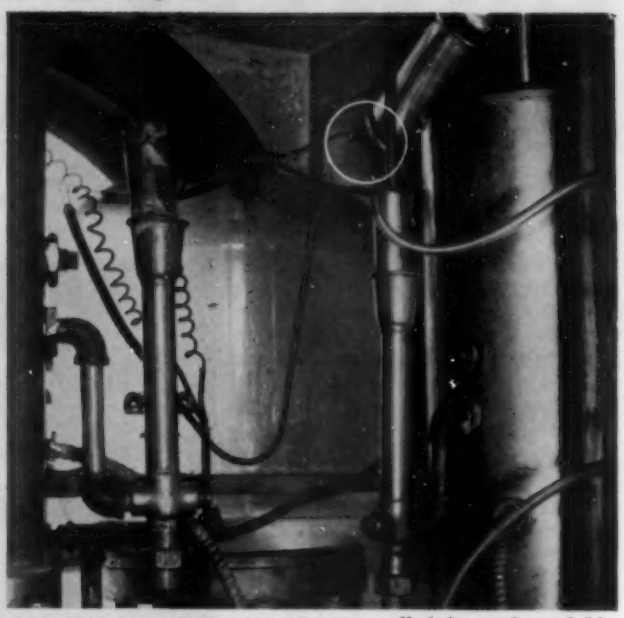
HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

How would you solve these tricky temperature control problems?

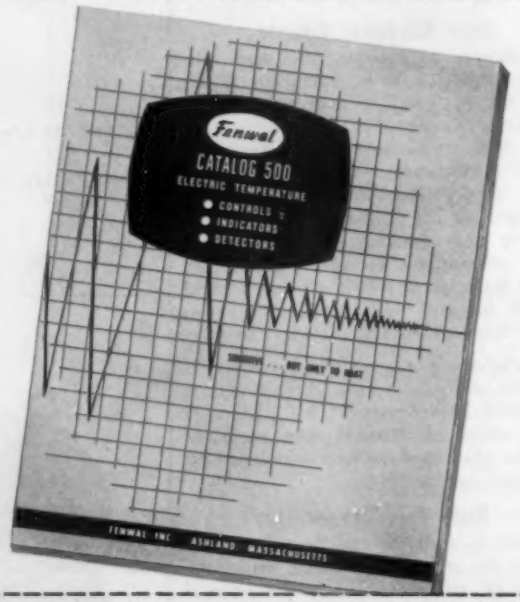


1. CONTROLLING HIGH FREQUENCY HEATING. In this vulcanizing patch press, precise temperature control of the platens was required to prevent loss of electronic heat generated within the processed material. Fenwal's solution was two THERMOSWITCH® units, set at 400F, mounted on the platens. Result: a production rate of 3,000 patches per hour, compared to ordinary hot press methods of 30 per hour.



2. SAFETY IN A DISTILLING PROCESS called for a dependable failure alarm. A Fenwal THERMOSWITCH unit in the condenser's safety vent solved the problem. Now, should the cold water supply fail, steam blowing through the condenser tubes will hit the THERMOSWITCH unit. This control, set at 120F, will then open, shutting off the electric heaters and sounding a continuous alarm.

3. PROTECTING PRODUCTS. In this shoe lining smoother, the problem was twofold: to use the fewest possible thermostats; provide close temperature control in order to prevent burning of shoe leather. Fenwal's solution: a single adjustable THERMOSWITCH unit, mounted on one ironer and controlling two ironers. This halved the number of thermostats indicated, while providing precision temperature control.



4. SEND FOR NEW CATALOG, just off the press. It describes Fenwal's complete line of THERMOSWITCH units and new indicating controllers for industrial applications. Fenwal engineers are always glad to help on any of your temperature control problems. Write **Fenwal Incorporated, 211 Pleasant St., Ashland, Massachusetts.**

Fenwal **THERMOSWITCH®**

Controls Temperature — Precisely

How a shift in gears saved $256,000

Five million MUELLER BRASS CO. forged ring gears improve automatic transmission operation . . . at lower cost to the manufacturer.

Ever since one of the leading manufacturers of automotive transmissions began using ring gears forged from Mueller Brass Co. bearing bronze, production costs have been cut nearly $256,000. That's because the rough forging weighs less and is closer to finished size than a sand cast ring gear formerly used. This shift in gears resulted in a savings in metal costs, greatly reduced machining time and increased tool life. In addition, the use of forged gears has cut scrap loss and eliminated costly inspection rejects.

The performance of these forged ring gears is also far superior to the sand cast gear, which had a tendency to flake away and crack around the teeth, causing failures. More than five million forged ring gears have now been used in these transmissions without a single failure. Being porous, the sand casting was difficult to balance, but the forging has a dense, homogeneous structure that helps keep it in perfect balance.

Strong, long-wearing non-ferrous metal parts, forged to your specifications by Mueller Brass Co., can help reduce your costs and improve the performance of your products just as they have done in this transmission application. For complete information, write us today.

Write today for your complete set of Mueller Brass Co. engineering manuals.

MUELLER BRASS CO. PORT HURON 17, MICHIGAN

154

START HERE

if you Want
Top Performance in

HOSE

ACME
Hose Products
for applications
involving

High Pressures
High Strength
Flexibility
Durability
Misalignment
Expansion
Contraction
and
Resistance to
Vibration
Shock
High
Temperature
Abrasion
Wear
Corrosion
Oil & Solvents

Every length of ACME'S varied line of RUBBER HOSE is specially engineered to meet the requirements of the application for which it is recommended. It is made by hose specialists in a plant devoted solely to hose manufacture for 53 years. What are your needs? Chances are we have it readily available in stock. If not, we'll make it for you.

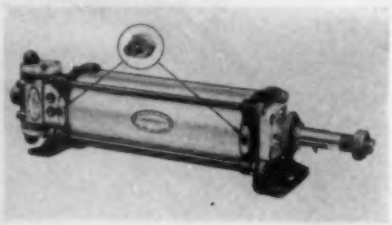
PUT THE JOB UP TO.....

Acme

HOSE SPECIALISTS

ACME RUBBER MANUFACTURING CO.
1431 EAST STATE STREET TRENTON, N. J.

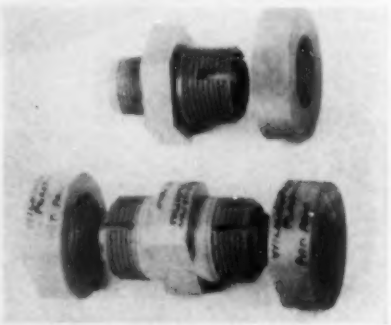
Fluid Power and Control



valves are available for 8 v or 110 v momentary contact electrical control (including explosion-proof models); 110, 220, 440, or 12 v maintained contact control; direct mechanical or manual control; air-pilot valve control; and air-poppet valve control.

The motor is available in all standard mounting styles. Operating at air pressures as high as 175 psi, it is said to develop a thrust equal to five times the air pressure applied. Bellows Co., Akron 9, Ohio.

For more information—
Circle 82, inside back cover



Fittings For Polyethylene Pipe

Couplings and adapters for use with polyethylene pipe are injection molded from rigid, unplasticized pvc. They are said to form a tight joint without setting up undue compressive stress in the polyethylene.

They are presently available in couplings (polyethylene-to-polyethylene) and adapters (polyethylene-to-metal) in ¾ and 1 in. sizes. Wilmington Plastics Co., 810 S. Heald St., Wilmington, Del.

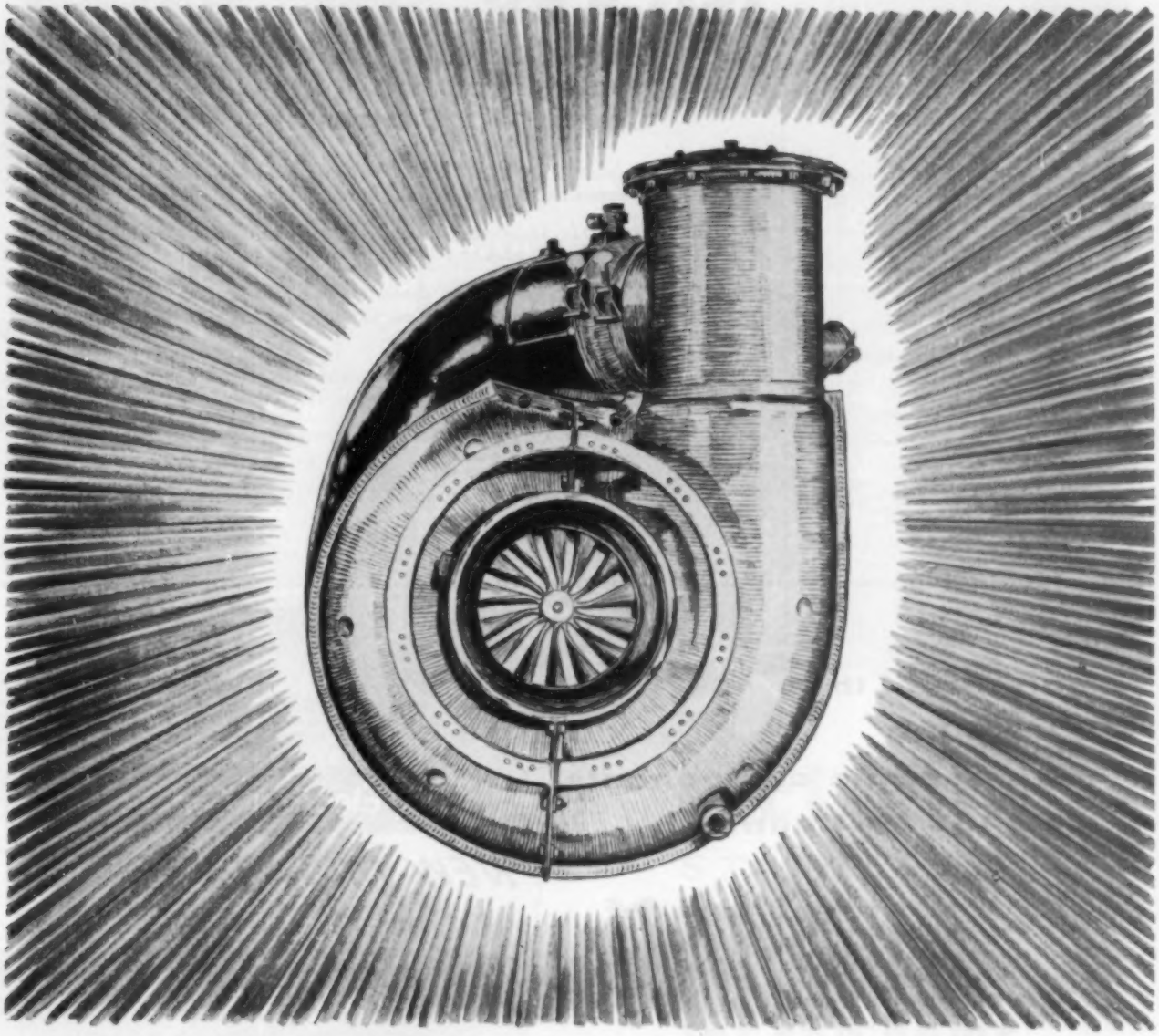
For more information—
Circle 83, inside back cover

PVC Fittings and Tubing

A line of instrumentation fittings made of unplasticized polyvinyl chloride and, for use with them, flexible

(Continued on page 314)

POWER PLANT OF THE FUTURE



The Solar "Mars®" Gas Turbine Engine

THE SIMPLEST PRACTICAL fuel-burning engine yet constructed is shown above. It is the Solar Mars 50 hp gas turbine. It weighs less than 100 lb and fits in a two-foot cube. It operates on a variety of fuels. Its construction is simple. And the ruggedness of the Mars engine has been proven by many thousands of hours of trouble-free service.

The Mars is a constant speed engine for emergency or stand-by duty where fuel consumption is not of primary importance. Your forward planning should include the Mars gas turbine. For detailed information about this power plant of the future, write today to Solar Aircraft Company, Dept. B-85, San Diego 12, Calif.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO DES MOINES

ENGINEERS WANTED *Unlimited opportunities in Solar's expanding gas turbine program! Write today, giving your experience.*

DESIGNERS, DEVELOPERS AND MANUFACTURERS OF METAL ALLOY PRODUCTS · GAS TURBINES · BELLOWS · CONTROLS · HIGH TEMPERATURE COATINGS · AIRCRAFT COMPONENTS

Completely Insulated for stability under long, hard operating conditions

There's nothing else like

ISO-KAP*

Centralab's New Molded Disc Ceramic Capacitor

Actual Size

Only one of its kind! The only molded, *completely* insulated, ceramic disc capacitor. Breakdown to ground in excess of 3000 V.D.C.

Strong! Unaffected by extremes of vibration; by ozone, salt water, or any known acid or solvent at room temperature.

Accurate! Thickness, diameter, and lead spacing are always exact. And leads are always on perfect center line—never offset. The answer for automatic assembly.

Dependable! New basic ceramic body. Capacitance characteristics are virtually flat over a wide temperature range.

Leads can't pull out! Lead strength is greater than the tensile strength of No. 22 wire.

Clearly labeled! Stamped with capacity, voltage rating, and tolerance.

Write for engineering bulletin EP-48, for facts and figures on Iso-Kap.

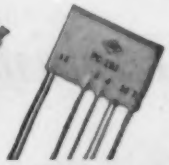
More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's advanced engineering continues to create the prototypes of the components industry

CONTROLS

CERAMIC CAPACITORS

SWITCHES



PACKAGED ELECTRONIC CIRCUITS

STEATITE INSULATORS

Electroni-Kwiz No. 9
NEW THIS MONTH!
1st Prize—Two single electric blankets
Don't be fooled! You have a good chance to win. Simply answer this question in 50 words, more or less:
How do you feel personally about the matter of patent rights? Should they belong to the individual inventor — or to the company who employs him?
A leading editor will pick the winner of this month's major prize.
Mail your entry to us before November 30.

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie. Entries become the property of Centralab—none can be returned.

D-5912

Centralab

A DIVISION OF GLOBE-UNION INC.

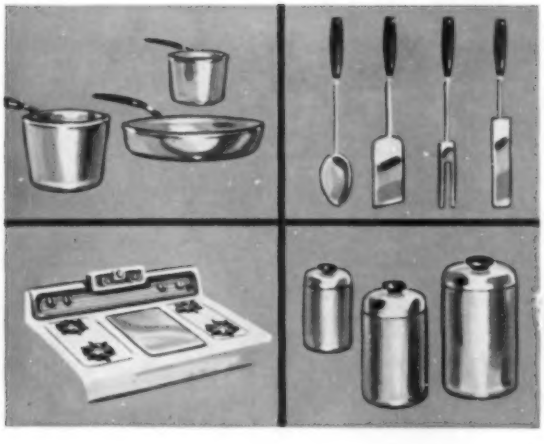
918K E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

*Trademark

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

modern design specifies stainless steel

McLouth
STAINLESS
Steel
for the home



The lady agrees with the architect that her modern, cheerful, Stainless Steel kitchen will be the most beautiful room in the new house. Stainless Steel is the bright, long lasting metal that will not tarnish, is easy to clean and a joy to live with.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.

McLouth Steel Corporation
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS

now FOR DC OR RESISTANCE INPUT

MODEL 200-A uses an input of 10,000 ohm resistance potentiometers as an input transducer providing 10 to 1 scale expansion and origin positioning. Available standard digital input accessories are essentially inputs of this type. Any resistance potentiometer will provide an analog input for this configuration.

MODEL 200-B, used for D.C. signal input, has full scale sensitivities of 5 millivolts and an input impedance of 1,000 megohms. Utilizing standard reference cells, this model provides drift-free operation. Available external reference voltages may be substituted. A plug connection is provided to facilitate the quick interchangeability of input sections.

now FOR SIMPLIFIED OPERATION

Precision Vernier Dials provide an accurate method for obtaining fine adjustment during operation. Optional point plot or continuous line plotting is a feature of both models. Selection is by front panel manual control. A new, simplified pen of one-piece design-used for point or continuous plotting—eliminates bottles and tubes, permits rapid changing of ink colors. Independent action of the X and Y axis is achieved with Librascope's unique "Floating Gear Train." No cables, tapes or lead screws to cause lost motion, cable stretching or drifting out of alignment. The 120° concave cylindrical plotting surface provides full visibility . . . is completely illuminated.

now FOR WIDER APPLICATION

These fast, dependable general purpose plotters feature 0.1% accuracy, are suited for wide applications where rapid graphic presentation of data is required, such as: laboratory testing, computers, data handling systems, wind tunnel, missile tracking and quality control testing of transistors and other electronic components. Input selection includes Punched Card and Tape Converters, Decimal Keyboards and Binary Converters. Model 200-A can plot from Flexowriter tape in any code or directly from the Tape Punch cables of many digital computers. Subchassis can be supplied to handle time-shared X versus Y plots, or other special circuitry. Write today for details.

LIBRASCOPE X-Y PLOTTER

HIGHEST ACCURACY FOR GRAPHIC DATA HANDLING

Greater input flexibility | For desk or rack mounting

NEW LIBRASCOPE PUNCHED TAPE CONVERTER
Operates from a punched tape reader—Specially designed for Librascope X-Y Plotters—This unit is adaptable to other plotters.

LIBRASCOPE X-Y DECIMAL KEYBOARD
Consists of three-decimal bank for each axis with associated plus minus keys. Features Librascope designed positive-action self-wiping contacts.

LIBRASCOPE PUNCHED CARD CONVERTER
Converts punched card data to analog form for input to X-Y Plotters. Automatic Position for feeding 50 punched cards per minute.

LIBRASCOPE INCORPORATED • 808 WESTERN AVENUE • GLENDALE, CALIFORNIA

A Big Reason Why More Firms Are Switching to Copyflex . . .

PROBLEM-FREE INSTALLATION and OPERATION!

Model 93

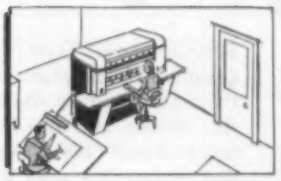
Because Copyflex reproduction machines are completely free from fumes and odors, they require no exhaust venting . . . they need no plumbing or auxiliary equipment, no installation other than an electrical connection.

Because they are absolutely clean, quiet, and odorless, they can be operated *anywhere* without annoyance to personnel in the vicinity.

That's why the people who handle reproduction, and know it best, prefer Copyflex. It's a big reason why more and more firms are switching to Copyflex!

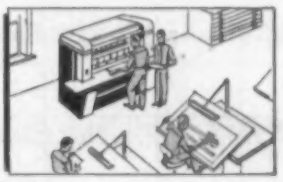
Why settle for less when it costs no more to own the one machine that offers you *all* the advantages of diazotype, positive black-on-white reproduction—speed . . . economy . . . quality—*plus* trouble-free installation and ideal operating conditions!

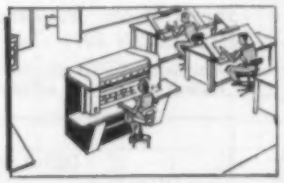
You'll find that Bruning also gives you the widest selection of reproduction materials available anywhere. Mail coupon for information on models and prices—today!



PUT IT HERE . . .
Near an inside wall—no plumbing, no ducts!

PUT IT THERE . . .
Near an outside wall—no vents in walls, windows!





PUT IT ANYWHERE!
Needs only an electrical connection for operation!

BRUNING *Copyflex*

Best Process! Best Machines! Best Selection of Materials!

Specialists in Copying Since 1897

Charles Bruning Company, Inc., Dept. 113-0
4700 Montrose Ave., Chicago 41, Ill.

Please send me information on Copyflex Reproduction Machines.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

CHARLES BRUNING COMPANY, INCORPORATED • 4700 MONTROSE AVENUE • CHICAGO 41, ILLINOIS

An Aid to PRODUCTION!

EX-CELL-O

These pictures show how Ex-Cell-O Corporation uses Barco Type NV Revolving Joints on its Style 112-C Ex-Cell-O Precision Boring Machine tooled for Bor-Drilling and countersinking bushings from the solid.

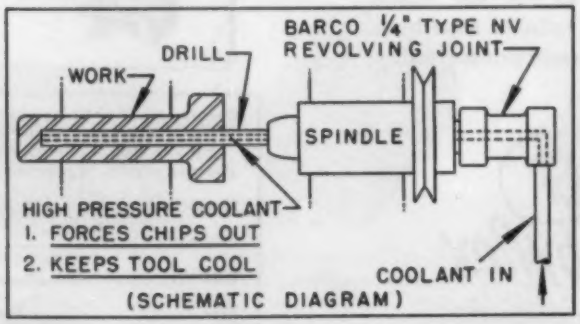
BARCO

Type NV Revolving Joints

Barco's new ¼" Type NV Revolving Joints are especially designed for machine tool applications. Ex-Cell-O uses them to introduce coolant under high pressure through the spindle and Bor-Dril to force out chips and keep the tool cool (see arrows above* in circle view showing end of machine with guard removed.) Barco Type NV Joints are well-suited for this application because of their precision construction and compact design. Sealed internal ball bearings are lubricated for life. Exclusive V-ring seals are self-adjusting for wear, require no lubrication, and permit operating speeds as high as 2500 RPM. Joints are suitable for use on pressures to 300 psi (air) or 1500 psi (hydraulic). Temperatures to 180° F. *Send for complete information and BULLETIN 307.*

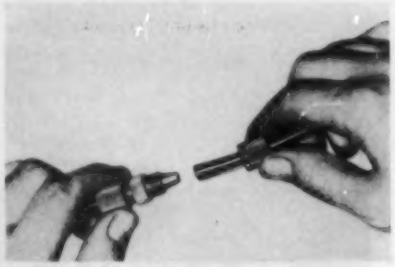
**Alternate spindles do countersinking operations, and do not require coolant through the spindles.*

ASK FOR BULLETIN 307



BARCO MANUFACTURING COMPANY
527M Hough Street • Barrington, Illinois

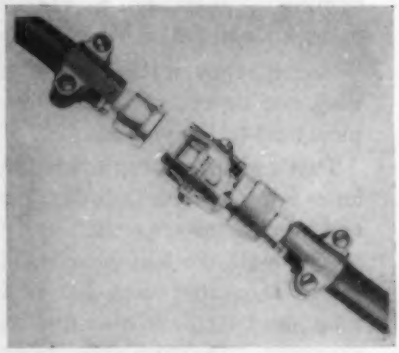
Fluid Power and Control



tubing, are said to permit an entire assembly to be put together by hand without the aid of wrenches, flaring or bending tools, or stretchers. No sleeves or ferrules are involved. A knife or scissors cuts the tubing to length.

The fiittings and tubing are furnished in both ¼ and ⅜ in. sizes. The types of fittings immediately available are half-unions, for joining plastic to male pipe thread; unions and bulkhead unions for joining plastic to plastic; connectors for joining plastic to female pipe thread, and caps. Maximum working pressure is 150 psi at 75 F. Tube Turns Plastics, Inc., 224 E. Broadway, Louisville 1, Ky.

For more information— Circle 84, inside back cover

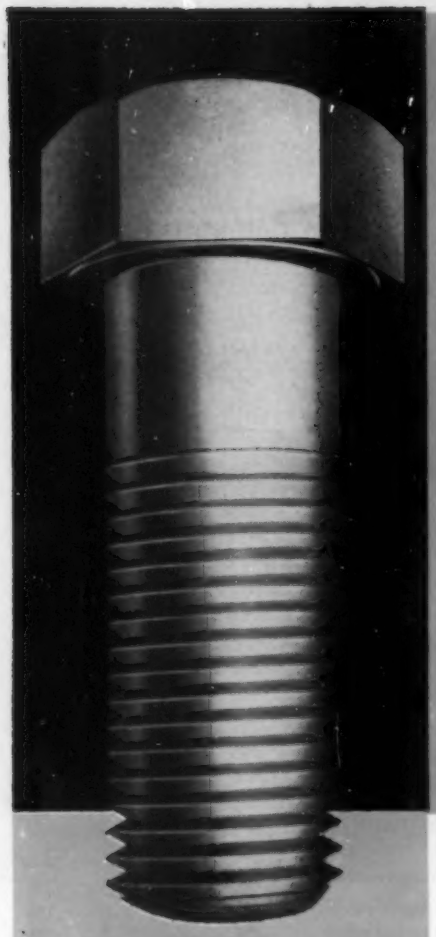


Detachable Valve Coupling

These valves are designed to permit line air to be shut off and tools changed at any point.

After connecting the jaws of the valve half around the shoulder on the connection half, the operator advances the knurled brass sleeve to "on" position. This permits line air to flow through the sleeve and out through the line to the air-operated tool. Turning the sleeve to the right locks both the coupling and the valve in "on" position, preventing accidental discon-

(Continued on page 318)



Lamson

1035 CAP SCREWS OFFER GREATER STRENGTH AT...

Less Cost!

If you are now using Full Finished Screws in your assembly operations it will pay you to consider substituting Lamson 1035 Double Heat Treated Cap Screws.

The extra relative toughness of Lamson 1035's enables you to use screws of smaller diameter, yet with equal, or greater, tensile strength.

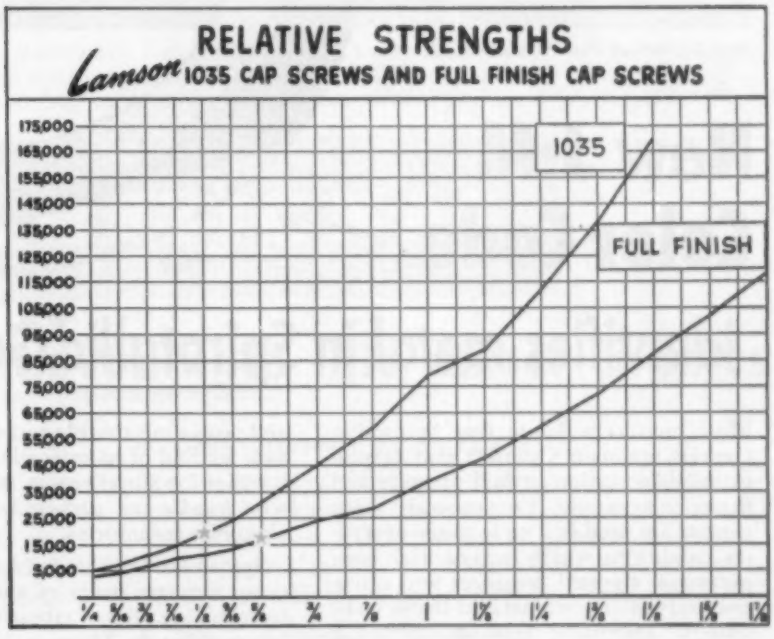
As an example of increased strength at less cost—on the chart below you will see that a ½"* diameter Lamson 1035 Cap Screw has greater tensile strength than a ⅝"* diameter Full Finished Cap Screw. This means savings in weight and size of assembly.

As for money savings—Lamson ½" x 2" 1035 Cap Screws are net priced at $5.36 per hundred as compared to $7.59 per hundred for the ⅝" x 2" Full Finished Screw. Proportionate savings can be made all along the line.

Lamson 1035 Double Heat Treated High Tensile Cap Screws have long been favorites where extra strength and durability is required.

To attain this extra strength, Lamson Cap Screws are first heat treated at about 1600° F. and then quenched. This imparts "hardness". Then the screws are "drawn", or re-heated, to between 900° F. and 1100° F. and then quenched in a special oil.

This results in a minimum tensile strength of 150,000 pounds per square inch.



YOU GET MORE WHEN YOU BUY FROM . . .

Lamson & Sessions

The LAMSON & SESSIONS Co.

1971 West 85TH St. • Cleveland 2, Ohio

CLEVELAND AND KENT, OHIO • BIRMINGHAM • CHICAGO

Painting, courtesy Power Magazine

New J-M Color Code

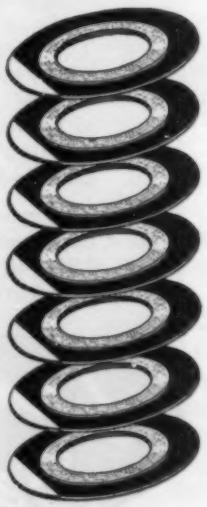
identifies metal in Spirotallic® Gaskets

Most engineers know that Spirotallic Gaskets maintain a perfect seal despite extreme fluctuation in fluid pressure and flange compression. Consequently, these gaskets are used in a wide range of service conditions which include high temperatures, elevated pressures and active corrosives. To withstand these conditions, Spirotallic Gaskets employ a variety of corrosion-resistant alloys.

Because so many of these metals look alike, only expensive tests or costly experience with the gasket could determine the gasket metal used, once its identifying tag was lost. Now the color patch on the centering guide tells the metal employed and saves time, trouble and expense. This new method of identification also makes it easier for storekeepers and mechanics who handle the gasket. In addition, it simplifies inventories.

Spirotallic Gaskets hold their seal because they are made of spirally wound interlocking plies of asbestos and spring-like metal strip. These gaskets compress easily with light bolting. For catalog PK-35A and copy of color code card write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Here are seven of the metals available and their color identifications



Zinc-coated steel—white

Type 304 Stainless—yellow

Type 316 Stainless—green

Type 347 Stainless—blue

Monel—orange

Copper—brown

Aluminum—aluminum

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville SPIROTALLIC GASKETS

Widely used as original power, International diesels are available in a wide variety of sizes and modifications. Two IH diesels are used here . . . 115 hp unit in ¼-yd dragline, 190 hp unit in 200-ton-per-hour crusher.

only INTERNATIONAL builds all these major advantages into diesel engines

1. Full-flow lube oil filters lengthen engine life

New replaceable plastic impregnated full-flow filters increase engine life by removing all harmful particles from the oil before it goes under full pressure to engine bearings. Exceptionally large filter area extends filter change period to 500 hours under normal conditions.

2. New injection pump reduces maintenance

Time proven International single and twin plunger pumps have been further simplified for longer life and lower cost maintenance. Scavenging gears and pump air pipe are eliminated . . . hardness of injection plunger increased for up to four times longer life.

3. Drilled passages assure full-time lubrication

You can be sure *all* engine bearings will be lubricated at *all* times. Lube oil is pressure-pumped through internal rifle-drilled passages that can't rupture or work loose.

4. Clean combustion on low-cost fuel

Trouble-free single orifice injection nozzles, and pre-combustion chambers mounted at 45° angle thoroughly mix fuel and air under all load and speed conditions. You get follow-through power strokes, clear exhaust, smooth idling on low-cost No. 2 fuel.

5. Fast, sure starting . . . always

Never mind cold—IH diesels work year 'round, even in the Arctic. Seconds-fast, they start in any weather on gasoline . . . and, seconds-fast, you switch to clean-burning, full-diesel power.

Six sizes of diesels, 52 to 190 hp, complete with radiator and fan. Also 12 models, 16½ to 200 hp, for gasoline, natural gas or LPG. See your nearest International Distributor for details.

INTERNATIONAL
INDUSTRIAL POWER

"powder to part"

Quality Controlled Fluorocarbon Plastics

U.S.G. quality control extends through every operation in the fabrication and custom molding of parts from duPont TEFLON, Kellogg KEL-F and BAKELITE fluorothene.

This quality control insures uniform electrical, chemical and physical characteristics of the highest quality. It also assures uniform density and dimensional stability permitting superior accuracy and dependability in the finished part.

Get the advantages of these fluorocarbon plastics at their best. Whether your requirements are for sheets, rods, tubing, tape, bars, cylinders, beading, electrical spaghetti, or parts extruded, molded or machined to your specifications . . . see U.S.G.

Write for Bulletin No. 300.

UNITED STATES GASKET COMPANY
Camden 1, New Jersey

USG

FABRICATORS OF FLUOROCARBONS & OTHER PLASTICS
Representatives in principal cities throughout the world

nection. An easily replaceable O-ring in the steel nose piece of the valve half is sealed against a recess in the stainless steel nose piece of the connection half by line pressure.

These new safety type valve couplings are available in ¼, ⅜, ½ and ¾ in. for line air up to 250 psi. C. B. Hunt & Son, Inc., Salem, Ohio.

**For more information—
Circle 85, inside back cover**

Swivel Joint

This swivel is of two-piece construction spun together at time of manufacture. Two types are available—one which turns free and one which incorporates an adjustable brake shoe to effect the desired drag or torque. Both may be obtained in ½ and ¾ in. pipe sizes. The swivel rotates a full 360 deg and is intended for occasional or intermittent turning rather than continuous rotation. Emsco Mfg. Co., Box 2098, Terminal Annex, Los Angeles 54, Calif.

**For more information—
Circle 86, inside back cover**

Coupler for Liquid, Gas Transfer

Coupler said to be designed for rapid transfer of liquids or gases was originally designed for the liquid fertilizer industry to provide the most efficient method of transfer, and to allow high speed filling of tanks from top or bottom. As the solution can be transferred and maintained under pressure, loss of vapor or tank pressure is prevented. The coupler arrangement consists of a filler valve that is

(Continued on page 322)

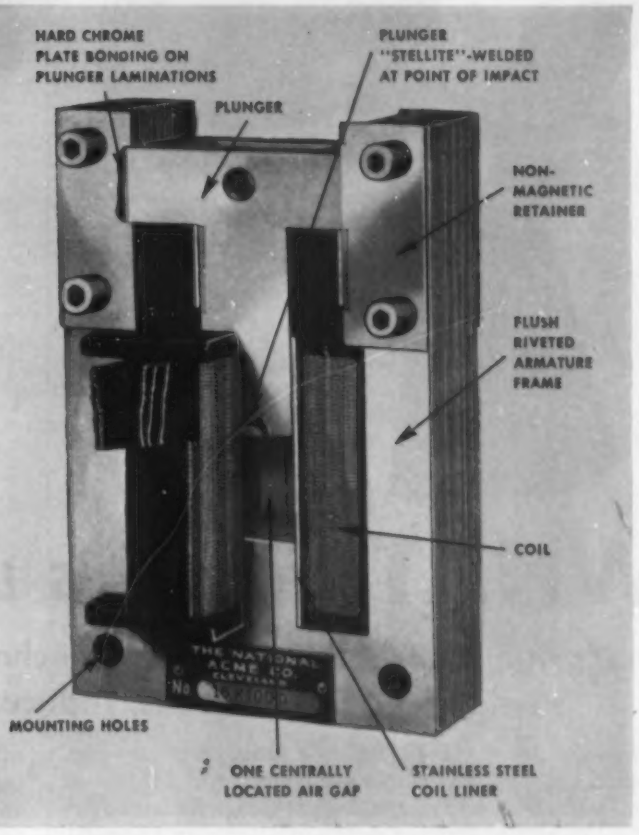
compact · rugged · reliable

NAMCO "Stellite"-welded

solenoids

assure positive, dependable action; with simplified manufacturing and maintenance *on jobs like these*

- actuate clutches
- operate switches
- control machines
- print identifying symbols
- operate safety devices
- eject work in process
- actuate clamping
- move levers
- operate valves
- vibrate cutting knives
- open and close doors
- hold chucks
- open and close hoppers
- sort inspected parts



Namco Solenoids, with "Stellite"-weld plunger contacts are built in a wide range of standard sizes (2½ to 21 lbs. at ½" stroke and 4 to 25 lbs. at 1" stroke); in push type, pull type, or combination push-pull type. They are available for either AC or DC service, and with standard or special terminal blocks and mountings.

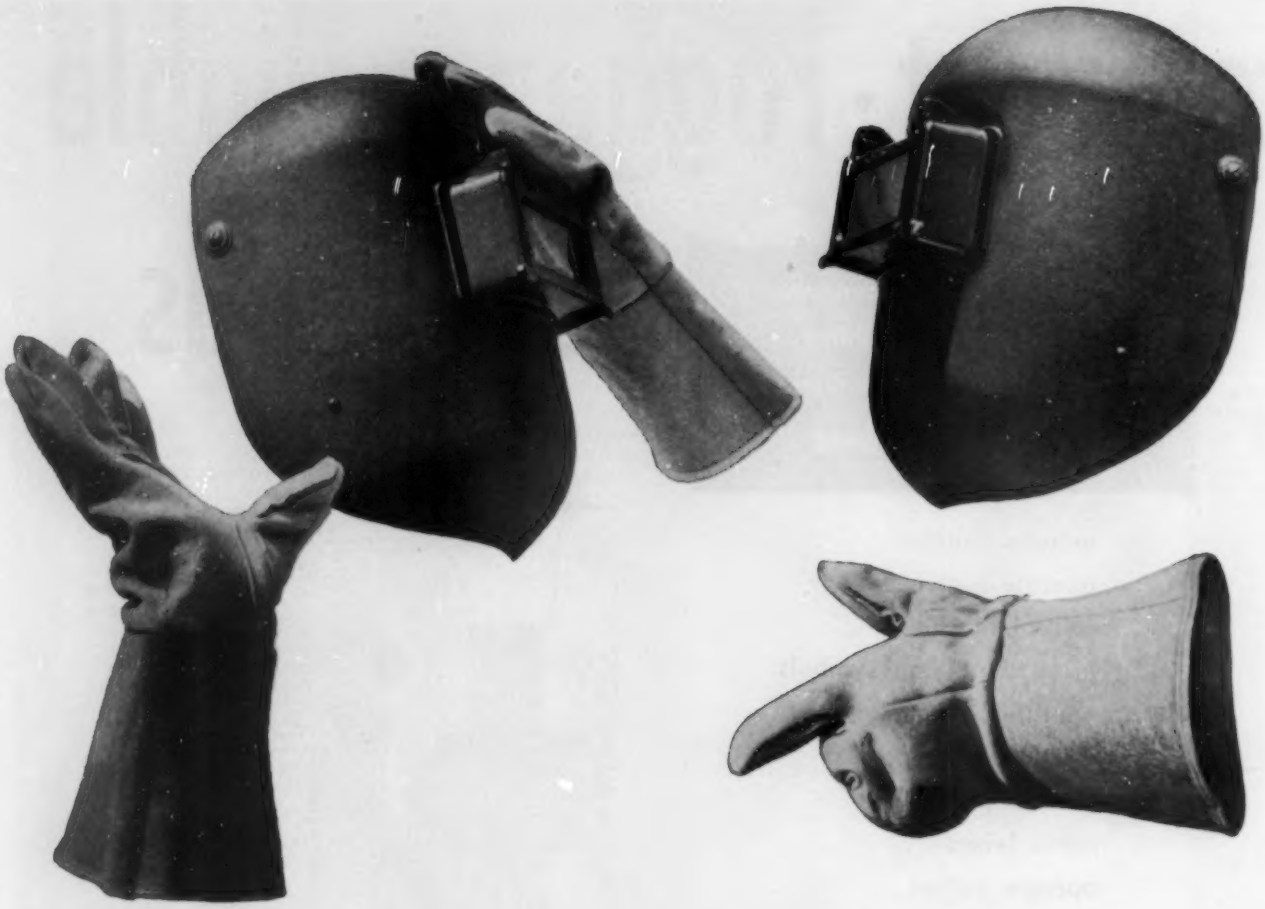
Other types of units for special application are also available—and experienced engineering assistance, to assure the most satisfactory application of Namco solenoids as a thoroughly dependable part of your product, is yours for the asking.

WRITE FOR BULLETIN EM-52. It gives complete engineering data, as well as suggestions for selection of the proper types. Also shows construction and design features and typical applications.

ELECTRICAL MANUFACTURING DIVISION

THE NATIONAL ACME COMPANY

170 EAST 131st STREET • CLEVELAND 8, OHIO



WHAT—*HANDLES LIKE CARBON STEEL?*

That's right. Worked with the same techniques as carbon steel, Lukens "T-1" steel cuts equipment costs, reduces field fabrication headaches.

Although Lukens "T-1" steel is a tough, high strength, heat treated steel, designers and engineers will find that its ready weldability and excellent wear characteristics will pay off in design freedom and increased equipment efficiency. Because this low carbon, quenched and tempered steel poses no unusual problems in welding, equipment can easily be fabricated, modified or repaired not only in the shop but also in the field. Three times stronger than carbon steel, this new steel has lighter weight and reduced thickness in comparison to heavier, thicker plates of carbon steel, thereby reducing material, construction and shipping costs.

Lukens' range of steel plate sizes—including the widest and heaviest plates available anywhere—makes possible additional savings through the use of wider plates that require fewer welded seams. Lukens "T-1" steel's resistance to the combination of wear and impact abuse lowers maintenance and replacement costs, lengthens equipment life.

The latest addition to Lukens' complete line of carbon, alloy and clad steels, this new steel's unusual combination of properties suit it especially to applications in pressure vessels, bridges, shipbuilding, construction machinery and general industrial equipment. On problems of design, material selection, application and fabrication techniques, Lukens offers full technical assistance. If you would like further information on Lukens "T-1" steel, write to: Manager, Marketing Service, 775 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

LUKENS

"T-1" STEEL

To get the new, 28-page book on Lukens "T-1" steel, ask for Bulletin 781.

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS

LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

ASCO

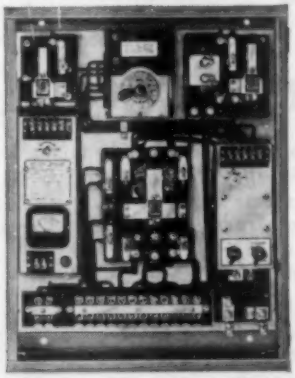
the one source for
ELECTROMAGNETIC CONTROLS
that offers engineers complete design flexibility

When designing equipment requiring electromagnetic controls, many engineers have found it saves them money if they first talk with an ASCO engineer before specifying solenoids, contactors or relays. His advice will help you cut initial cost, improve your final product and simplify automatic control.

Most important, the ASCO representative can recommend not only standard and special purpose controls, but can also offer the development services of ASCO, the one source that offers engineers complete design flexibility. His knowledge will allow your imagination free rein—unshackle you from the limits of designing with only conventional controls in mind.

Why not have an ASCO engineer call . . . or write outlining your problem. We shall be happy to assist you.

COMPLETE CONTROL PANELS



ASCO engineered and manufactured panels are provided by combining ASCO controls with purchased equipment as needed.

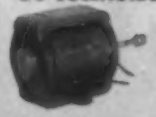
AC SOLENOIDS

104S1
Stroke up to ¾"

104S4
Stroke up to 1⅝"

DC SOLENOIDS

106S4
Stroke up to 1"



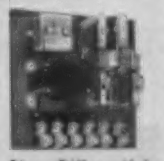
106S14
High Pull
Stroke up to 1"

106S76
Fuel throttle control.
Stroke up to 1¾"

SPECIAL PURPOSE RELAYS

Reverse Current

Brake Motor Time Delay



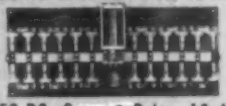
Close Differential

Coil-less

Electronic

MAGNETICALLY HELD RELAYS

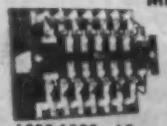
1055 AC—2 to 12 Poles, 10 Amp.



1058 DC—2 to 12 Poles, 10 Amp.

1054 AC—
1 to 3 Poles,
25 Amp.

MECHANICALLY HELD RELAYS

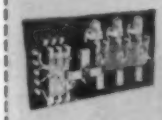


1256-168S—AC
2 to 12 Poles, 10 Amp.

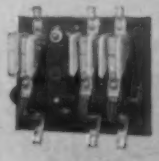
1255—AC-DC
1 to 5 Poles, 25 Amp.

1255-166S—AC
1 to 6 Poles, 25 Amp.

CONTACTORS



Contactors for computers



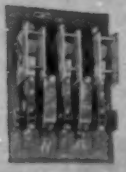
1035 AC, Normally Open

1045 AC-DC, Double Throw

1025-111S DC, Low Voltage, High Amperage

1044 AC-DC, Normally Closed

1025-131S DC, Field Discharge



911-187S, AC-DC, Feeder Switches

AC-DC, Marine Duty

WRITE US FOR MORE DETAILED INFORMATION ON ASCO ELECTROMAGNETIC CONTROL EQUIPMENT

ASCO®

Automatic Transfer Switches
Electromagnetic Controls
Solenoid Valves

Automatic Switch Co.

165 Lakeside Avenue, Orange, New Jersey

Standard 12 stop Intermittor with specially jig-bored 36" dial.

HIGH SPEED INDEX TABLES FOR LARGE VOLUME PRODUCTION

Up to 30,000 Pieces per Hour with

The FERGUSON INTERMITTOR!

Standard 6 stop Intermittor with 12" dial and optional tool mounting brackets.

OVER 150 STANDARD MODELS TO CHOOSE FROM:

NO. OF STATIONS
4, 6, 8, 12, 16, 24, 36

DIAL SIZE
12", 18", 24", 30", 36", 48

INDEXING TIME
¼, ⅓, ½, ¾ of cycle

COMPLETE CATALOG

Every engineer should have a copy of Catalog No. 300 which gives load ratings and all dimensions of more than 150 standard Intermittors. Send for your file copy today . . . no obligation.

The new standard Ferguson Intermittor is a *must* for operations such as machining, joining, forming, staking, piercing, assembling, testing and inspection that require a combination of high speeds, long dwell or work time, and smooth indexing.

There is a standard Intermittor for almost every application, offering a choice of stops, dial size, degree of movement; and a table for either extreme precision or high torque usage. Seldom do you have so much selection in a line of standard production machinery . . . with all of the benefits of standardization PLUS many of the advantages of custom designs! The Intermittor operates at speeds far greater than those possible with other types of index tables. The special acceleration characteristics of the FERGUSON ROLLER GEAR DRIVE insure smooth starting and stopping with little shock and vibration, at speeds up to 500 indexes per minute.

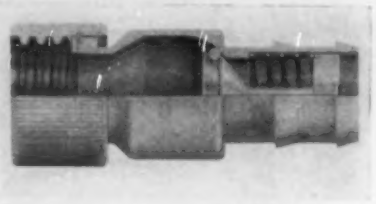
Save design time, simplify tooling, improve product quality and cut maintenance costs to rock bottom with the new Ferguson Intermittor . . . the "Packaged" precision index table for high speed production.

WRITE FOR CATALOG NO. 300

FERGUSON MACHINE & TOOL CO., INC.

ROLLER GEAR DIVISION, DEPT. BI-11, P. O. BOX 5841, ST. LOUIS 21, MO.

Fluid Power and Control



threaded into the tank and a coupler for quick connection between the host and filler valve. The filler valve incorporates a check valve unit to permit flow into the tank and automatically shuts off when the coupler is disconnected. James-Pond-Clark, 2181 E. Foothill Blvd., Pasadena 8, Calif.

For more information—
Circle 87, inside back cover

High Pressure Hose and Couplings

Included in this line are single wire braid, rubber-covered hose; double wire braid, rubber-covered hose; and single wire braid, cotton-covered hose. Hose conforms to both SAE and JIC standards. A range of hose couplings and adapters is offered for each type. Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.

For more information—
Circle 88, inside back cover

Liquid Level Control

In this floatless liquid level control, operating coils are completely covered with a moistureproof compound. The operating relay is of the plug-in type, double-pole double-throw, furnished in a clear plastic case. Gulow Controller Co., 301-303 Hackensack St., E. Rutherford, N. J.

For more information—
Circle 89, inside back cover

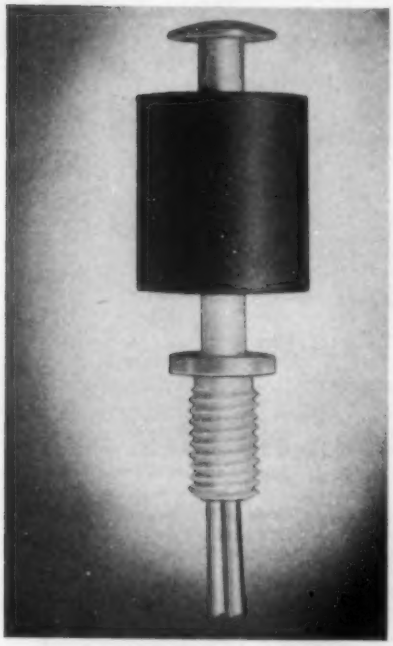
Fluid Transfers

This device transfers fluids under pressure from a stationary source to rotating equipment. Capabilities range up to 1000 psi fluid pressure and 10,000 rpm shaft speed. Typical applications are on deep or precision hole drilling equipment for transferring the coolant to the drill point for chip removal and for cooling the cut-

(Continued on page 323)

ting edge. Other transfers are used on hydraulic equipment to transfer pressurized fluids to cylinders or clutches. Sealol Corp., 197 Post Road, Providence 5, R. I.

For more information—
Circle 90, inside back cover

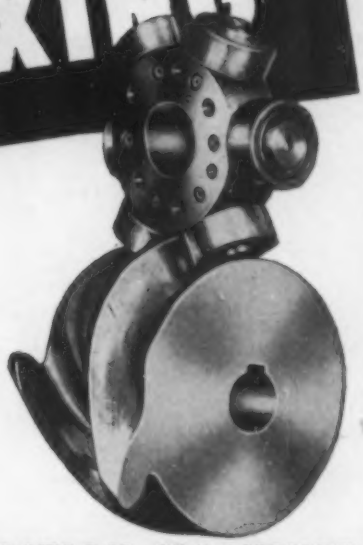


Float Level Indicator

A hermetically sealed float level indicator, weighing 0.9 oz, for control or indication of levels of various liquids, is now available. The indicator has no exposed metal parts and may be used with solvents, oils, acids and other chemicals. The hermetically sealed, single-pole, single-throw

(Continued on page 326)

HIGH SPEED INDEXING



WHEN TO SPECIFY A FERGUSON DRIVE

IN YOUR NEW PRODUCTION MACHINERY

WHEN INDEXING SPEEDS LIMIT YOUR PRODUCTION...

OR YOU NEED PRECISION OF .001" WITHOUT AUXILIARY LOCKING DEVICES...

OR IF YOU REQUIRE SMOOTH STARTING AND STOPPING...

OR IF MAINTENANCE "DOWN TIME" IS A MAJOR PROBLEM...

There's No Place in Automation for Obsolete Indexing Devices

Modern production methods require speeds and precision impossible to obtain with geneva drives and other obsolete indexing devices. The Ferguson Roller Gear Drive makes it possible to increase production speeds as much as 100%, *while improving product quality and reducing maintenance costs!* The Ferguson Drive, the greatest development in indexing in the last thirty years, attains indexing speeds up to 1,000 per minute in some applications without undue shock or vibration to the Drive or machine. If you have machinery utilizing dial feeds, roll feeds, carrier chains and other types of intermittent feeding methods, investigate the Ferguson Drive and discover what it can do for you.

NOW IN STOCK!

CUT WEEKS OFF DELIVERY TIME!

The more widely used Ferguson Drives may now be ordered from stock with weeks cut off delivery time and prices reduced as much as 25%. Send in the attached coupon or write for Bulletin 105a to get full information, including load ratings, dimensions and data on selecting a Drive. Find out how inexpensive it is to modernize your production machinery, increase production and lower operating costs.

FERGUSON MACHINE & TOOL CO., INC.
ROLLER GEAR DIVISION
P. O. BOX 5841 ST. LOUIS 21, MO.

FERGUSON MACHINE & TOOL CO., INC.
Roller Gear Division Dept. B-11
P. O. Box 5841 St. Louis 21, Mo.

Send free copy of bulletin 105a and data on stock and standard Ferguson Drives for high speed precision indexing of production machinery.

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ STATE_____

In the field . . . *Vibration pickups on the tractor and on the driver's back are wired to Brush Recording System in the station wagon. Vibration analysis helped engineers design a better tractor seat, which reduced operator fatigue—an important sales point!*

PORTABLE BRUSH RECORDING SYSTEMS

speed your testing and development

WHEREVER you have measurement problems *on the job*, these portable recording systems simplify your tests, save valuable engineering time. They are lightweight, easy to set up, simple to operate. While noted for high accuracy, they are rugged and durable. You can quickly obtain *written records* of stress, strain, force, vibration, torque, pressure, electrical variables, etc.

Brush amplifiers and direct-writing oscillographs provide complete systems for recording one, two, four or six channels of data simultaneously. Our representatives can help you in application. For complete information write Brush Electronics Company, Dept. L-11, 3405 Perkins Avenue, Cleveland 14, Ohio.

In the shop . . . *Here wave form and timing of welding current is recorded simultaneously with electrode pressure. This helps inspectors calibrate controls quickly, assure better welds, meet specifications.*

New . . . *Brush four and six-channel portable oscillographs provide a choice of 8 or 16 chart speeds, permitting excellent visual presentation of a great variety of signals. Units are portable and lightweight.*

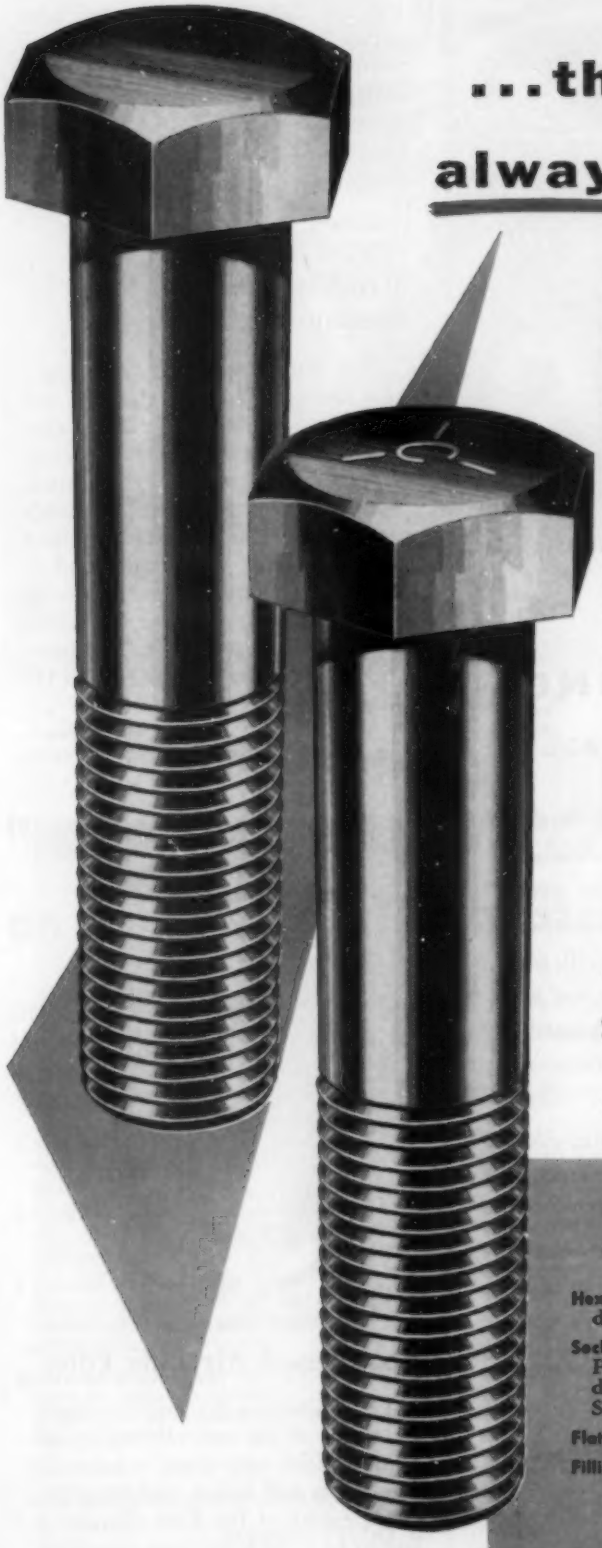
BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH 6 ELECTRONICS

Division of Clevite Corporation

Which is the CleCap?



...the one that's always ready for you

We're never "out of stock" on any of the popular sizes in High Carbon Heat Treated Cap Screws—CleCap's pride and joy among tough dependable hex head screws.

One thing you'll soon learn when you deal with CleCap—as cap screw specialists, we haven't so many irons in the fire that we can't keep our production well balanced and maintain stocks to meet demands. And we make it a point to stock many sizes and lengths not commonly listed.

It's good business to use these extra tough 1038s. And it's good business to order them from the hustlers at CleCap—or from one of the many efficient CleCap distributors.

Approximate Tensile Strength*
(Lbs. per Sq. In. Minimum)

Stock screws are double heat treated to SAE Grade 5 physical properties

Up to ¾" dia. inclusive	120,000
Over ¾" to 1" dia. inclusive	115,000
Over 1" to 1½" dia. inclusive	105,000

**Based on mean thread area.*

The Cleveland Cap Screw Co.

2936 EAST 79th STREET • CLEVELAND 4, OHIO

VU Ican 3-3700 TWX CV42

Warehouses: Chicago • Philadelphia • New York • Providence • Los Angeles

CLEVELAND *Top Quality* FASTENERS

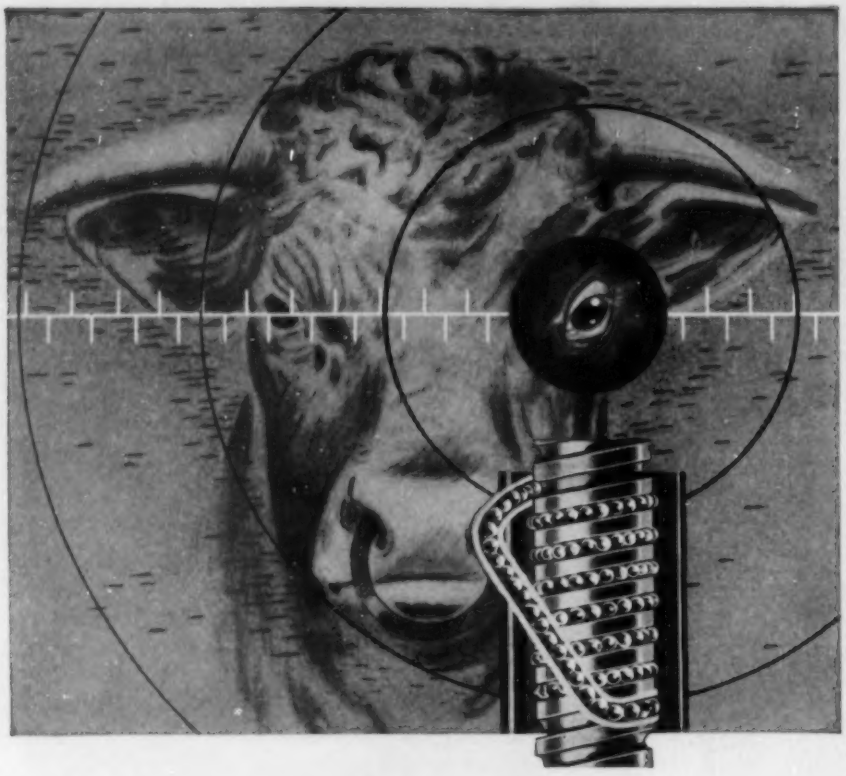
Ferrous and Non-Ferrous: Bright, High Carbon and Alloy Steel Heat Treated, Brass, Silicon Bronze, Stainless Steel

- Hex Head Cap Screws—¼" to 2½" dia.
- Socket Head Cap and Set Screws—Plain and Knurled: ¼" to 1½" dia. Also Flat and Button Head Styles
- Flat Head Cap Screws—¼" to 1" dia.
- Fillister Head—¼" to 1" dia.
- Set Screws—Square Head—¼" to 1½" dia.
- Milled Studs—¼" to 1¼" dia.
- Place Bolts—¼" to 1¼" dia.
- Structural Bolts to ASTM Specification A325
- Tractor Bolts
- Special Hot and Cold Headed Parts

Facilities to make larger diameters than listed

Ask Your Jobber for CleCap!

Originators of the Kaufman DOUBLE EXTRUSION Process



you can achieve

BULL'S-EYE POSITIONING

WITH THIS SCREW THAT ROLLS ON BALLS

Pin-point positioning is possible with an AEROL Ball-Screw mechanism even under the most adverse temperature conditions. Because AEROL Ball-Screws move entirely on friction-free steel balls, they permit an assembly to move effortlessly and to position *exactly* at the desired spot... with no springiness, no drift, no rebound. Because they require no lubrication, they allow you to operate in high-temperature areas without fear of fire and thinned-out grease, and in low-temperature areas without the problems of stiffened grease and sluggish operation.

Because AEROL Ball-Screws are friction-free, their use can greatly increase drive efficiency, allowing you to save on motor size and weight, first cost, space and electricity required.

AEROL Ball-Screws are at work now in many varied applications. They have proved to be the best answer to many design and operating problems. They may solve a problem for you. To get more information, write for our free booklet.

Cleveland Pneumatic
Tool Company CLEVELAND 5, OHIO
DEPARTMENT E-1155

AIRCRAFT GROUND HANDLING EQUIPMENT
BALL-SCREW MECHANISMS • AIR-OIL IMPACT ABSORBERS

WORLD'S LARGEST MANUFACTURER OF AIRCRAFT LANDING GEARS

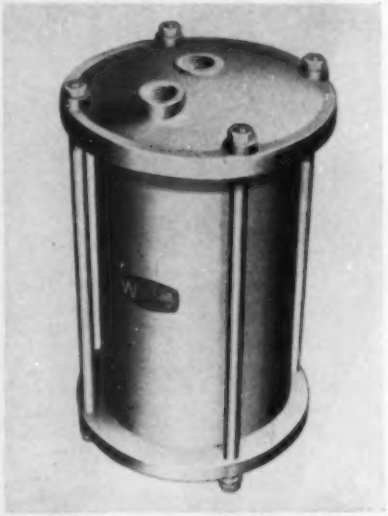
switch, rated at 10 w load at 115 v, ac, 0.5 amp resistive or inductive load at 28 v, dc, is said to have a 100,000 cycle minimum life. This switch is enclosed in a nylon stem and is actuated by permanent magnets imbedded in the free float. The indicator is 3.31 x 1.22 in. dia. Revere Corp. of America, Wallingford, Conn.

For more information—
Circle 91, inside back cover

Stainless Steel Pressure Snubber

This unit protects sensitive gages from sudden pressure changes and eliminates wild fluctuation of the gage pointer, permitting more accurate readings. The snubber is T-shaped, providing for adjustment through the side chamber without disturbing line connections. Three pins used in combinations offer 13 gradations of damping adjustment. Rated working pressure is 5000 psi. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

For more information—
Circle 92, inside back cover

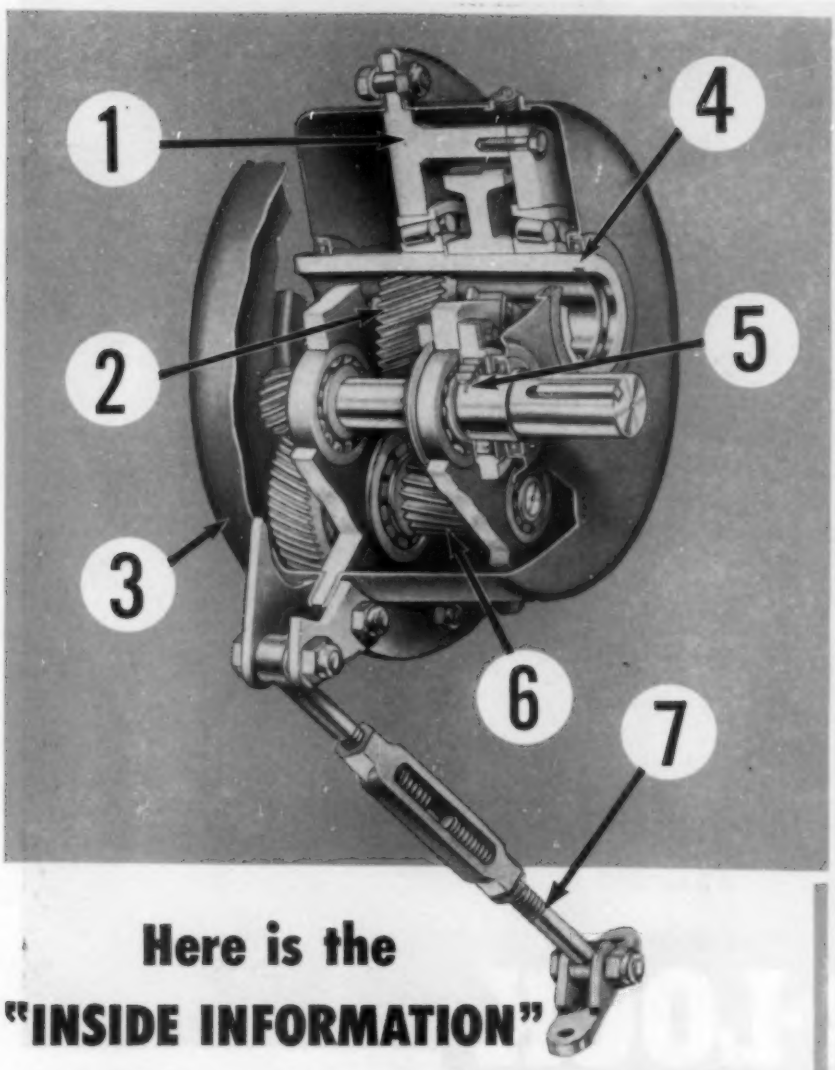


Compressed Air Line Filter

These filters are designed to remove all traces of oil and oil vapors, all solid particles over three microns in size, odors and fumes, and moisture. Replacement of the filter element is said to be a quick and easy procedure.

In operation, oil, vapors, moisture and contaminants are diverted around

(Continued on page 330)



Here is the "INSIDE INFORMATION" on FALK ALL-STEEL Shaft Mounted Drives

Take a careful look inside the Falk all-steel Shaft Mounted Drive, and you will know why this newest member of the famous Falk family is ideal for applications where direct mounting on the driven shaft is desirable. It is the only drive in its field with all these superior "In-built" factors:—

1 **All-steel Frame,** with more than double the rigidity of iron, supports all rotating elements.

2 **Precision Helical Gears,** designed and machined by Falk, rated to AGMA standards.

3 **Pressed Steel Housings,** whose sole function is to keep oil in, dirt out; easily removed for gear inspection without dismounting unit.

4 **Through Hollow Shaft** with counter bore provides for easiest installation or removal from driven machine shaft extensions.

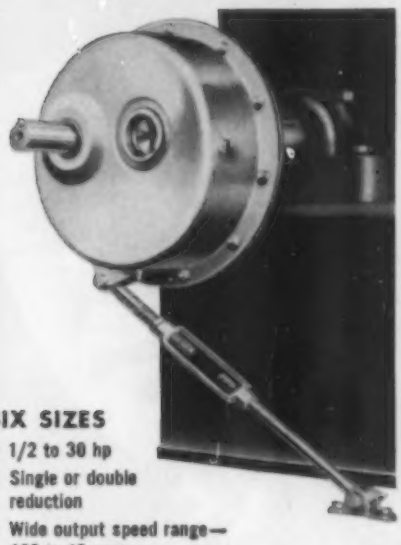
5 **Backstop** can be furnished with the unit or added later for positive prevention of reverse rotation.

6 **Positive Lubrication,** continuous direct dip of revolving elements at all speeds.

7 **Tie Rod** and turnbuckle serve as anchor and facilitate V-belt or chain adjustment.

Write to Department 247 for engineering bulletin, including selection and dimension details.

EFFICIENT SPEED REDUCTION IN LIMITED SPACE

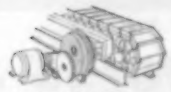


SIX SIZES

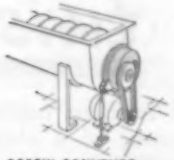
- 1/2 to 30 hp
- Single or double reduction
- Wide output speed range—420 to 10 rpm

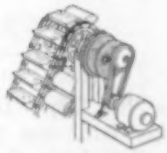
Expressly designed for topflight performance on installations requiring considerable speed reduction in limited space, the all-steel FALK Shaft Mounted Drive has quickly won acceptance throughout industry. This sturdy, compact, versatile reducing unit is an ingenious variation of the highly successful FALK Motoreducer design, pacemaker in its field for more than 20 years. Here, the time-proved design is adapted for mounting directly on the shaft to be driven, using V-belt connection to motor. Investigate now!

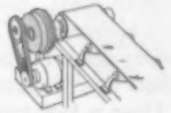
A FEW TYPICAL APPLICATIONS

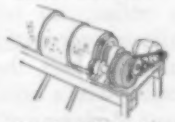

APRON FEEDER

LINE SHAFTING


SCREW CONVEYOR


BUCKET ELEVATOR


BELT CONVEYOR


GRAVEL CLASSIFIER

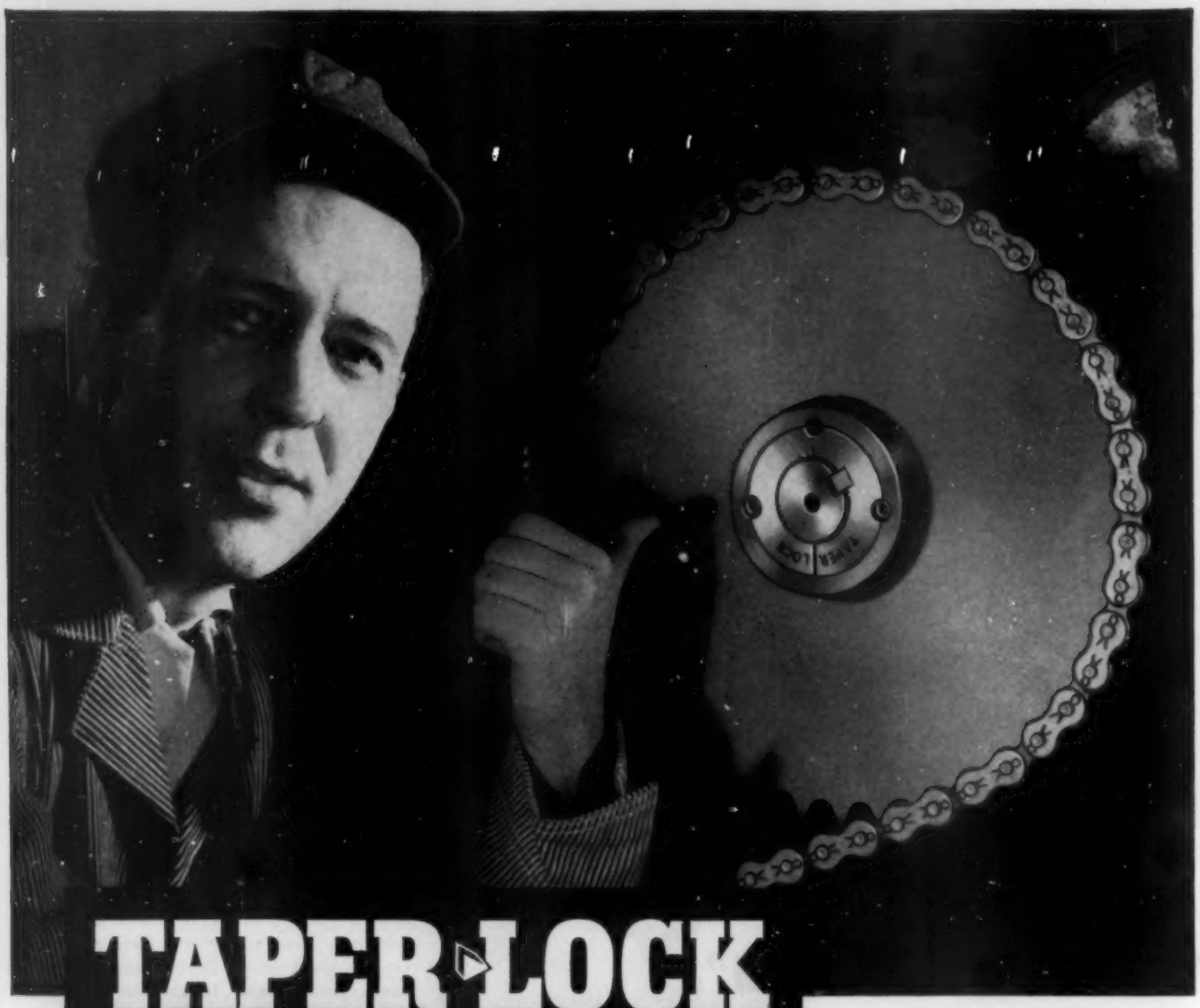
THE FALK CORPORATION, Milwaukee 8, Wisconsin

MANUFACTURERS OF

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

...a good name in industry



TAPER-LOCK

A PATENTED PRODUCT OF DODGE

Holds so tight it will twist a cold-rolled shaft!

Yes, the Taper-Lock bushing really grips the shaft—holds with the firmness of a shrunk-on fit. It seats evenly along the entire length of the hub. There's no collar, no protruding part, no flange to prevent uniform compression. Having full contact with both hub and shaft, the Taper-Lock bushing holds so tight it would twist a cold rolled shaft before it let go. *Until you want to demount it!* Then a few turns of a hex wrench will release it quickly and completely, without shock to bearings or machinery. For the full story call your Distributor—or write to

DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Ind.

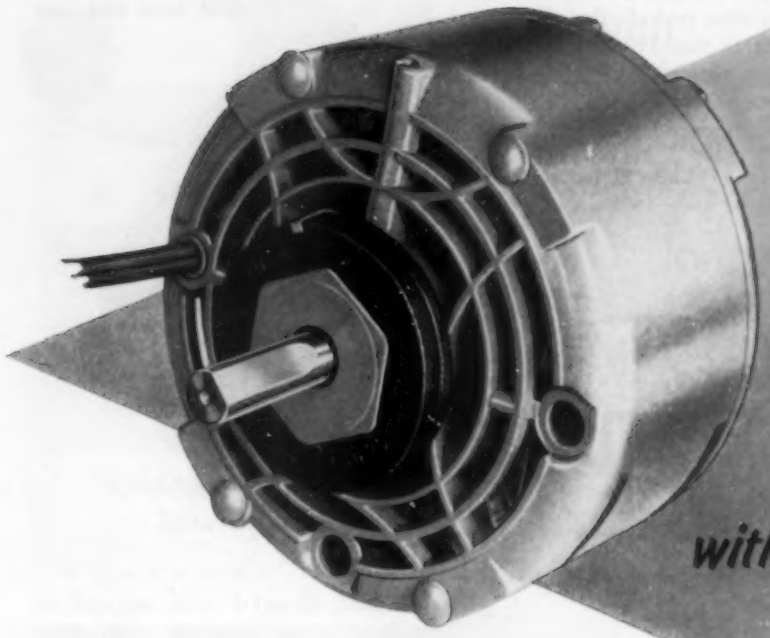
THERE'S ONLY ONE TAPER-LOCK, THE BUSHING THAT MOUNTS FLUSH!

Standardize, economize with Taper-Lock, the bushing that is interchangeable in Dodge sprockets, sheaves, couplings and conveyor pulleys. *More than 2,000,000 in use!*

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

DODGE

of Mishawaka, Ind.



Super SHADED POLE MOTOR

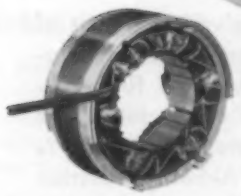
with *All* the good features

for air conditioning and air moving applications

You will boost sales by teaming your product with Lamb Electric *Super* Shaded Pole Motors. They will give your product the motor advantages of *long life, quiet operation, high operating efficiency, and lasting good appearance.*

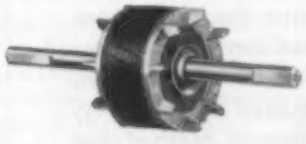
Behind Lamb Electric *Super* Shaded Pole Motors is our 40 years' experience working with manufacturers of household appliances, such as food mixers, sewing machines, floor polishers and vacuum cleaners . . . experience that has resulted in these 10 features:

- "UNI-SPUN" STATOR FRAME for maximum rigidity
- FORMVAR INSULATED WIRE WINDINGS for high strength and insulation resistance
- "AL-SPUN" ALUMINUM ROTOR CAGE for maximum conductivity
- DIE-CAST END FRAMES . . . sturdy, lightweight, corrosion-resistant
- BEARINGS widely spaced, amply dimensioned
- AMPLE OIL RESERVOIR . . . positive oil circulation
- SHAFT precision ground to controlled surface finish
- MOUNTING absorbs vibration
- ADVANCED DESIGN, quality materials, and up-to-date manufacturing methods
- FINISH . . . moisture and abrasion-resistant



"UNI-SPUN" STATOR FRAME

Anchored laminations, ample back iron, strong pole tips mean core rigidity, better heat dissipation, quiet operation.



"AL-SPUN" ALUMINUM ROTOR CAGE

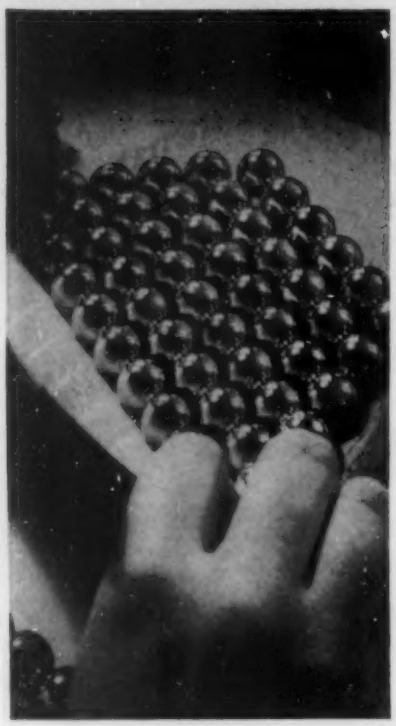
Heat-treated for lowest rotor losses. Integral cooling fan and vented core. Dynamically balanced.

VISIT US at the Air Conditioning and Refrigeration Exposition, Atlantic City, November 28-December 1—Booth 706—or write for folder giving full information.

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

FOR
UNIFORMITY



USE
ABBOTT BALLS

In any given shipment of Abbott carbon steel Bearing Balls you'll find UNIFORMITY of size tolerances and sphericity. This is because Abbott production standards are geared to meet Industry's most rigid requirements. Every Abbott Bearing Ball — *Deep Hardened and Tempered* for maximum shock resistance and load carrying ability — is a model of precision, unsurpassed for sphericity, size tolerance, depth of case and other essentials of fine carbon steel bearing balls.

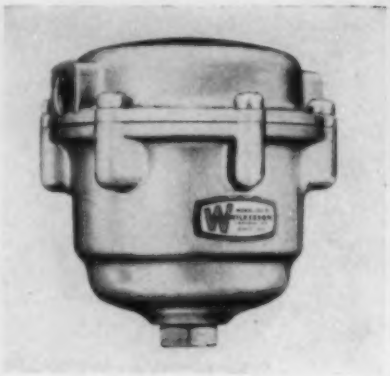
Specify Abbott . . . you can't ask for a better carbon steel ball!

THE ABBOTT BALL CO.
55 Railroad Place, Hartford 10, Conn.

the filter by a top baffle and into a sump at the bottom, as air is drawn through the filter to a center outlet port. The sump is fitted with a drain cock to allow periodic draining.

Units of the 350 series are being made in ¼, ⅜, ½, ¾, 1 in. sizes. Wilkerson Corp., 3387 S. Platte River Drive, Englewood, Colo.

**For more information—
Circle 93, inside back cover**



Moisture Discharge

A series of moisture discharging separators for compressed air equipment operating between 10 and 250 psi are piston-operated. These separators do not increase air requirements and are said not to flutter. Action is fully automatic in the separation and discharge of free oil, water and non-gaseous contaminants. Four models are offered, serving ¼ to ½ in. lines. Wilkerson Corp., 3387 S. Platte River Drive, Englewood, Colo.

**For more information—
Circle 94, inside back cover**

Eliminates Noise-Shock From Air-Operated Equipment

These all-metal units are said to reduce sound in overly noisy areas close to the level found in the average factory (75 decibels). Tests show that operating efficiency is in no way impaired while the noise is dampened. There are no parts that need replacing. They are corrosion-resistant and are reportedly safe for any pressure normally encountered in industrial pneumatic service. C. W. Morris Co., 10628 Cloverdale, Detroit 4, Mich.

**For more information—
Circle 95, inside back cover**

ENGINEERING MATERIALS

Leaded, Free Machining Steel Plate

Stated advantages of the new plate, compared with plate which depends on the addition of sulphur to provide free cutting quality, are improved machinability and superior welding, polishing and plating properties. Its flame cutting, forming, grinding, and case hardening characteristics are said to be equally as good as those of the free machining plate previously sold by this company.

Initially, the new steel plate will be available from stock in thicknesses from ¼ to 3 in. inclusive. Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill.

**For more information—
Circle 96, inside back cover**

Aluminum Foil Tape

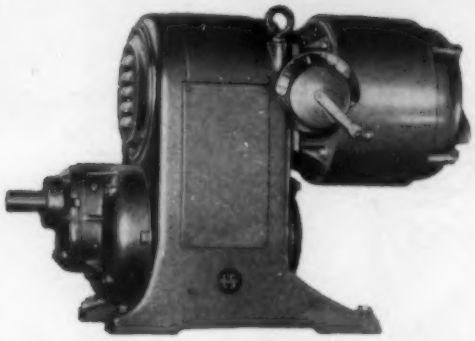
A pressure-sensitive aluminum tape used as a moisture vapor barrier in communication cable splices has been introduced. An 0.003 in., dead soft foil backing has a tensile strength of 33 psi. Adhesion is 25 oz per in. The tape is available in 2 in. by 20 ft rolls.

(Continued on page 334)

3 GREAT FEATURES

Unique with

U. S. VARIDRIVES



...for dependable, long-life, Variable Speed

With a U. S. Varidrive motor you can get instantly all the speeds needed for every operating condition. You can have infinite speeds at your instant command without resorting to cumbersome speed-changing contraptions and costly external equipment. The Varidrive combines all equipment in one compact "package," occupying little more space than an ordinary motor, for convenient installation.

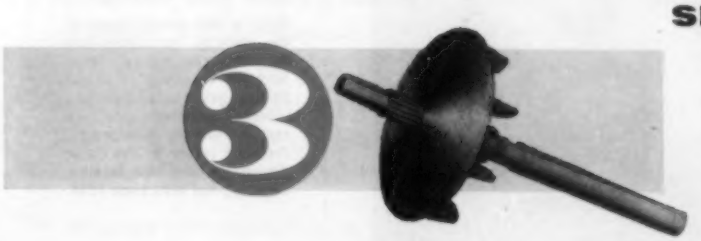
1 AUTOTAUT TENSION CONTROL

Autotaut automatically compensates for wear, stretch and changes in length of the belt drive due to temperature and, therefore, does not require manual adjustment. It establishes the exact tension by employing the positive movement afforded by a live, resilient spring which has been accurately calibrated at the factory.

2 DOUBLE-RIBBED BELT

By application of the double-ribbed design, smaller diameters and greater speeds can be combined. The result is maximum motor compactness. This type belt provides double corrugation, reduces internal friction and permits greatest flexibility. The Varibelt has highest resistance to heat, oil and grease, and is protected from drippings by complete enclosure.

3 SLIDING SPLINE



Instead of relying upon a common key to connect the shaft and sliding Varidisc, the U. S. Varidrive gears parts together with an involute spline. Load is equally among 16 integral teeth cut in the shaft. Both motor and driven shafts in the Varidrive are splined. Integral teeth provide maximum strength with minimum diameter, and reduce wear and vibration.

U.S. MOTORS

MAIL COUPON FOR INFORMATIVE FULL COLOR 16 PAGE BOOKLET

U. S. ELECTRICAL MOTORS INC. PRE-11
P. O. Box 2058, Los Angeles 54, Calif., or Milford, Conn.
Ask for Booklet #1797

NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

DIE CASTING REPORT

Uniformity - - Less Machining - - -
Corrosion Resistance - - Close Tolerances
- - are a Few Reasons Why

This wringer-type Maytag washer has 24 die-cast parts.

Wringer parts include: gear case, cap and clutch pulley.

Formerly sandcast, this washer cover is now an aluminum die-casting.

Maytag uses 15 to 20 million die cast parts per year!

Having produced over 9 million washing machines, no one knows better than Maytag Co. the importance of maintaining quality while meeting high production schedules. Die castings have helped solve the problem – at economical unit costs – by providing unlimited qualities of identical component parts. At the same time, aluminum and zinc die-castings have met the critical demands of functional applications. Examples of Maytag requirements. die castings must be (1) oil and water tight for gear cases and housings (2) true to dimension for line assembly with mating parts and (3) free and clear of external surface flaws.

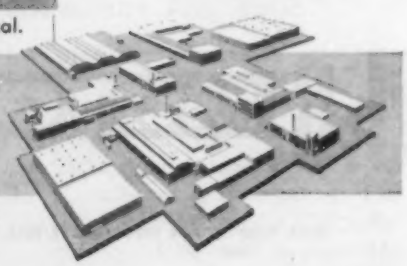
While Maytag is a large user, those with lower requirements may enjoy similar economies and advantages. Let our creative design engineers look at your functional or decorative part needs, at no obligation of course.

For a copy of: "Die-Castings Unlimited." Address: Precision Castings Company, Inc., 199 Walnut Street, Fayetteville, N. Y.

Small zinc die-cast components, mostly functional.

Switched to die castings from sand castings

Many of the die-cast parts in the Maytag automatic and wringer-type washer were formerly sandcast. Less machining, better surface quality, reduced finishing time are reasons for the changeover. Precision is one of the major die-casting suppliers to Maytag...and has been since 1938.



PRECISION CASTINGS CO., INC.

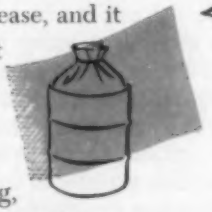
A SUBSIDIARY OF **Harrisburg Steel** CORPORATION

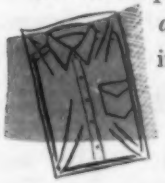
FAYETTEVILLE, N. Y. – SYRACUSE, N. Y. – CORTLAND, N. Y. – NEW YORK, N. Y.
CHICAGO, ILL. – CLEVELAND, OHIO – KALAMAZOO, MICH.

INVESTIGATE!

the unique properties of Krene® cast vinyl film

Here is a film that COMBINES *high-strength* with *excellent clarity* . . . and economy. These basic properties make KRENE Cast Vinyl Film a superior material for temporary glazing for windows, as wind breaks and side curtains for jeeps and tractors. Add *high chemical resistance* to most acids, alkalies, alcohol, oils and grease, and it makes excellent drum liners, or one-shot drums, for packaging corrosive chemicals. With *beautiful gloss* and *easy heat-sealability* KRENE Cast Vinyl Film is highly recommended for product packaging, or overwrapping, where a *clear, tough* and *puncture- and tear-resistant* film is required. And, in addition to all these attributes, it has very *low gas and water vapor transmission* . . . which, combined with its clarity, makes very efficient oxygen tents.





Why not investigate KRENE Cast Vinyl Film today? It's available in thicknesses from .001 to .012 in either 36 or 48 inch widths. For samples, write Dept. LP-145.

BAKELITE®
Krene®
Cast Vinyl Film & Sheeting

®UCC
®Registered trade-marks of UCC

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.

PANELOC announces a new rotary latch

Saves Cost • Saves Time
Saves Space • Saves Weight

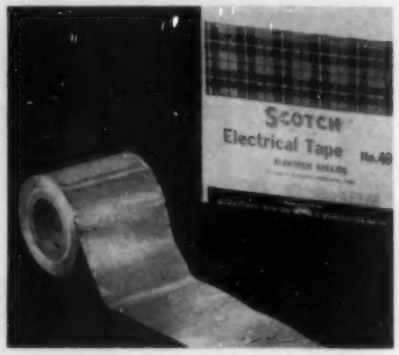
This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

PANELOC...America's most versatile line of aircraft fasteners . . . Rotary Latches, Styles 1, 2, and 3 Panel Fasteners, High Performance Fasteners, Snap Fasteners.

PANELOC—A product of Scovill

Scovill Manufacturing Company, Aircraft Fastener Div.
49 Mill Street, Waterbury 20, Connecticut
Please send me fastener catalogs checked:
( ) Rotary Latch ( ) Style 3 (MIL-F-5591A)
( ) Styles 1 & 2 (MIL-F-5591A) ( ) High Performance (NAS-547)
( ) Snap Fasteners (AN 227)
Send to:
Name_____ Title_____
Company_____
Address_____

Engineering Materials



Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn.

For more information—
Circle 97, inside back cover

Fluxless Aluminum Solder

This solder is said to require no flux, metal cleansing or physical shaping. It will solder foils, thin-gage aluminum, potmetals and zinc. Increased heat is asserted merely to increase the solder's capillary action, causing more intense welding by fusion. Torch, hot plate, stove burner or soldering guns may be used that are able to melt this new solder, which is available in very low (500 F), low (600 F) and medium (800 F) ratings. Chemalloy Electronics, Inc., Gillespie Airport, Santee, Calif.

For more information—
Circle 98, inside back cover

Molded Rubber Parts

Molded rubber goods, custom-produced to specification, are available in a wide range of rubber compounds, either natural or synthetic. Typical parts include air brake diaphragms, bumpers and snubbers, rubber wheels, gaskets of all kinds, spring inserts, oil seals, O-rings, rubber-covered rolls and idlers, regulator diaphragms and other parts. Quality Rubber and Transmission Co., Dept. Pen, 2203 W. Chicago Av., Chicago 22, Ill.

For more information—
Circle 99, inside back cover

Plating Method for Springs

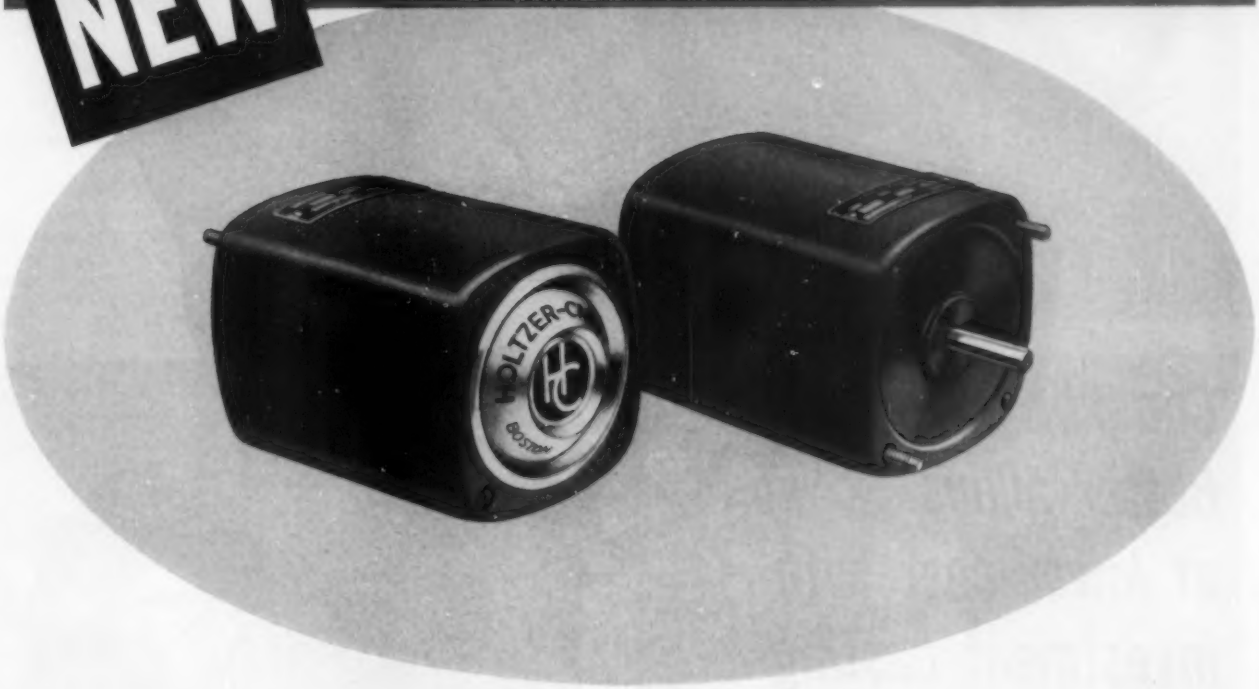
A nickel plating method has been developed for the finishing of springs, wire forms, electronic coils and fila-

(Continued on page 338)

HOLTZER-CABOT

Subfractional Motor in 3" dia. frame

NEW



This *completely new* motor — designed by Holtzer-Cabot and styled by Raymond Loewy Associates — rounds out the Holtzer-Cabot line of subfractional motors for instrument, recording units, office appliance and other applications. It provides an intermediate size between the Holtzer-Cabot 2½" and 3¾" frame motors.

The single phase motors in this 3" frame are the single-value capacitor type, the ideal class for single-phase operation. The efficiencies of the various ratings run over 30%. As a result, there is lower temperature rise and less heat to be dissipated.

The synchronous motors have a stainless steel shaft and new rotor construction. The class is basically of the reluctance type, but the rotor is completely cylindrical with no irregularities or slot openings. This construction promotes more uniform torque and quieter operation.

The stator has slotted construction with distributed windings. Mylar insulation is used in the slots. End caps are die-cast aluminum. Either ball or sleeve bearings are available. Standard construction provides face mounting by means of frame screws. Housings are furnished in opalescent blue (other colors on request).

Holtzer-Cabot will adapt the winding type, characteristics and mechanical details of this motor to ensure optimum performance for specific applications.

NOMINAL RATINGS FOR CONTINUOUS DUTY

Frame	*Synchronous*		*Induction*	
	1800 RPM	3600 RPM	1700 RPM	3400 RPM
3007	1/200	1/150	1/100	1/60
3012	1/150	1/100	1/75	1/50
3018	1/100	1/60	1/50	1/40

Mail coupon today for complete information

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
Sales Service Representatives in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: — Please send me data sheets on the new 3"-diameter frame HOLTZER-CABOT motor.

☐ Please have representative call..... (Date)

Name.....

Title.....

Company.....

Street.....

City.....*Zone*.....*State*.....

Complex shapes– Better alloys at lower cost with investment casting

Complete Design Freedom can be yours with investment casting. Ferrous and non-ferrous alloys including magnesium are cast with great detail, intricacy of shape and to close dimensions. Substantial Reductions In Production Costs are possible by reducing machining operations to the minimum.

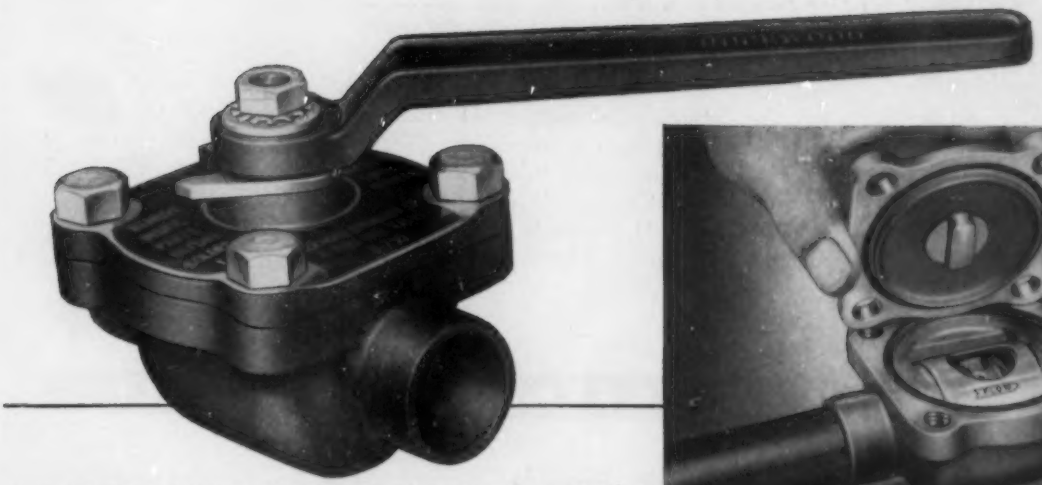
- Assembly costs are cut by combining two or more components into an integral casting
- Large and small quantity production (including prototypes) are cast economically
- Tooling costs are relatively low

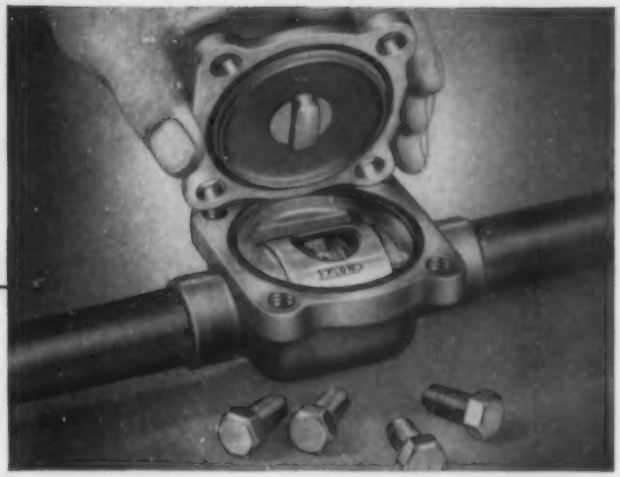
Arwood's four plants have complete tooling facilities and government approved inspection equipment.

If you use metal in your business investigate the possibilities of investment casting . . . send for literature or call for consultation. We welcome parts or prints.

ARWOOD **PRECISION CASTING CORP.**
68 Washington St. Brooklyn, N. Y.

PLANTS: Brooklyn, N. Y. • Groton, Conn. • Tilton, N. H. • Los Angeles, Calif.





FAST, LOW-COST CHANGE IN DIRECTION OF FLOW. Removal of the body cap permits reversing the cage assembly to allow change in direction of flow. In addition, this feature lets you change seat material, and clean the valves thoroughly and quickly — *without removing the valve from the line!*

INTERCHANGEABILITY of seat material to meet your operating requirements is another feature of the Rockwood Top Entry Ball Valve. Seat can be furnished in Buna-N, Neoprene, Kel-F, Teflon, and Nylon.

EASY INSTALLATION AND OPERATION is permitted because of the new handle design. This new design allows the handle to be placed in any of *eight positions!*

Now!... New Rockwood Top Entry Ball Valve

. . . A new concept in valves that saves you money and time!

Made of bronze the new Rockwood Top Entry Ball Valve is ideal for handling oxygen and hazardous liquids as well as water, oil and gas. It carries 300 lbs. per square inch on water, oil and gas and 400 lbs. per square inch on LP gas and is available both with sweat ends and screw ends, in sizes ½", ¾" and 1".

Write for complete data on this unique full round pipe size flow.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all Principal Industrial Areas

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
806 Harlow Street
Worcester 5, Mass.

Please send me complete information on Rockwood Top Entry Ball Valves.

Name.....

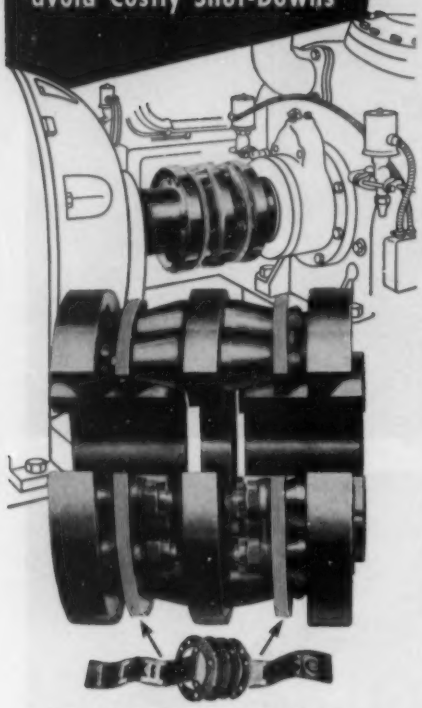
Title.....

Company.....

City.....

Zone....State.....

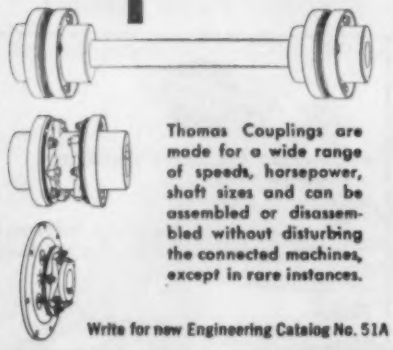
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

ment parts. The process is said to offer the following advantages: 1) evenness of coating, even on concealed surfaces hitherto impossible to plate; 2) uniformly bright surface; 3) ability to nickel-plate parts previously incapable of being retained in commercial nickel-plating barrels; 4) ability to plate correctly parts with a high tangling potential. Reliable Spring & Wire Forms Co., 3167 Fulton Road, Cleveland, Ohio.

**For more information—
Circle 100, inside back cover**

ENGINEERING EQUIPMENT

Adhesive Sheets Provide Standard Drawing Details

Multiple copies of any standard or special drawing detail can be prepared on matte-surfaced acetate sheets, with adhesive on either front or back, as desired. To apply, it is only necessary to peel off the protective paper coating, position the element on the tracing and press in place.

Title blocks, specification and revision boxes, instructions, symbols, standard and special components and cross-sections can be reproduced to order, with either one or several details per sheet. Blank sheets are also available to permit typing of non-standard information on drawings, eliminating hand-lettering. The adhesive used on this sheeting is heat-resistant and is said not to be affected by any reproduction process. Stanpat, Whitestone 57, N. Y.

**For more information—
Circle 101, inside back cover**

Model of Constant-Force Spring

To aid design engineers in the development of mechanisms based on the constant-torque spring motor, a working model of the B-motor form of the spring is now available. Smaller than the B-motor model previously introduced, it is mounted on a 1 x 1¾ in. plastic base and exerts a nominal 6 oz tension on the output cable, as it is extended through 36 in.

The spring in the model is a flat strip of stainless steel, 0.0025 in. thick and ¼ in. wide, which has been given a curvature by continuous heavy forming so that in its relaxed condition it is a tightly wound spiral. The spring is mounted on two low-friction aluminum bushings so that a constant force is exerted as extension of the output cable winds the motor from its relaxed condition on the smaller bushing onto the output bushing. The cable, stored on a drum integral with the output bushing, is equipped with a looped terminal attachment to permit either manual or mechanical extension from a stop mounted on the base. Constant torque of 0.11 lb-in. is developed through 20 revolutions of the output bushing at all positions of cable extension. Hunter Spring Co., Lansdale, Pa.

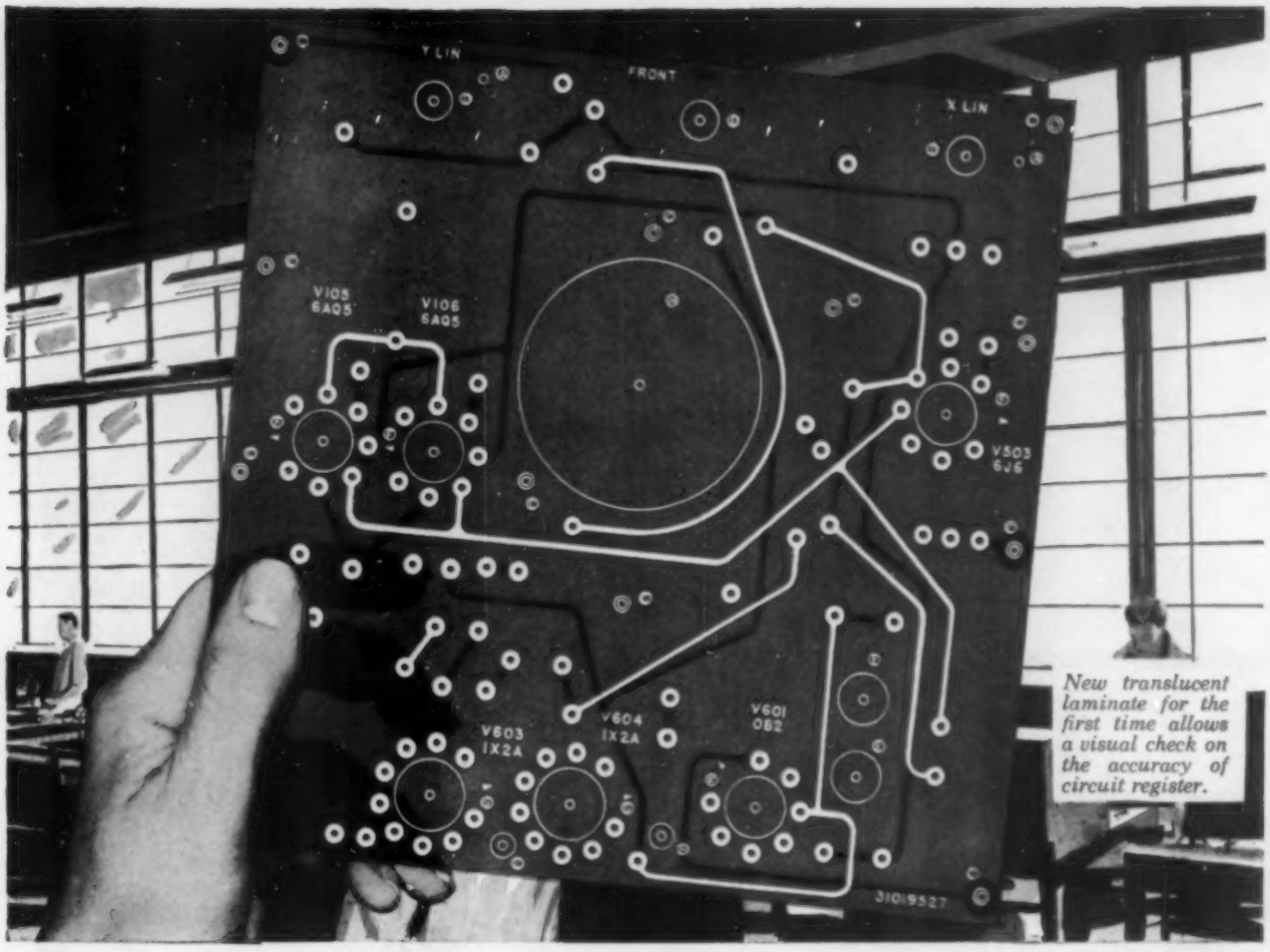
**For more information—
Circle 102, inside back cover**

Portable Test Generator

This English-built electric generator is capable of producing a high-voltage, low-current supply and can be operated either by cranking the generator handle or connecting to a-c mains. Operation of the unit depends on the arrangement of a generator rotor and a low voltage primary winding of a transformer so that they share the same iron core. A magnetic shunt switch closes and opens a pair of air gaps in this iron core to effect the alternative operation.

The device is designed as a power source for field testing of electrical

(Continued on page 342)



New translucent laminate for the first time allows a visual check on the accuracy of circuit register.

Formica Research perfects sensational new cold punching laminate

Brings 1,000,000 megohms resistance value, precision and translucency to printed circuitry . . . . .

Research, an important part of the exclusive new Formica 4-point service, has just perfected a new cold punching paper base laminate offering 1,000,000 megohms insulation resistance and valuable new translucent properties.

Known as XXXP-36, the new grade brings greater accuracy to printed circuitry. Because of its cold punching qualities, XXXP-36 requires no heat cycle. Therefore, the base laminate is not subject to dimensional change as in grades which must be heated before punching. This means that with Formica XXXP-36, you can now produce printed circuits with new and higher standards of accuracy.

XXXP-36 translucency can be doubly useful. Make this simple test: hold it to the light. You can see (1) the smooth, homogenous structure, the total absence of resin pockets, voids and imperfections that dissipate the insulating properties of ordinary paper base laminates . . . and (2) how perfectly the circuit on one side registers with that on the other. New XXXP-36 is ideal for terminal boards and tv insulators requiring high I. R. Formica's engineering skill can help you find new materials for new products and processes. For complete information on the new XXXP-36, or on the new "Formica-4" service, use coupon below. The Formica Co., 4676 Spring Grove Ave., Cincinnati 32, Ohio.

Industrial
FORMICA®
Laminated Plastic
Pays in Performance

FORMICA®—*the most famous name in laminated plastics—Engineered for industry, Beauty Bonded for the home.*

Make the Formica Translucency Test. Send for a sample XXXP-36 printed circuit. Fill out and mail coupon today.

Gentlemen:

☐ *I'd like a sample XXXP-36 printed circuit and complete information on this new grade.*

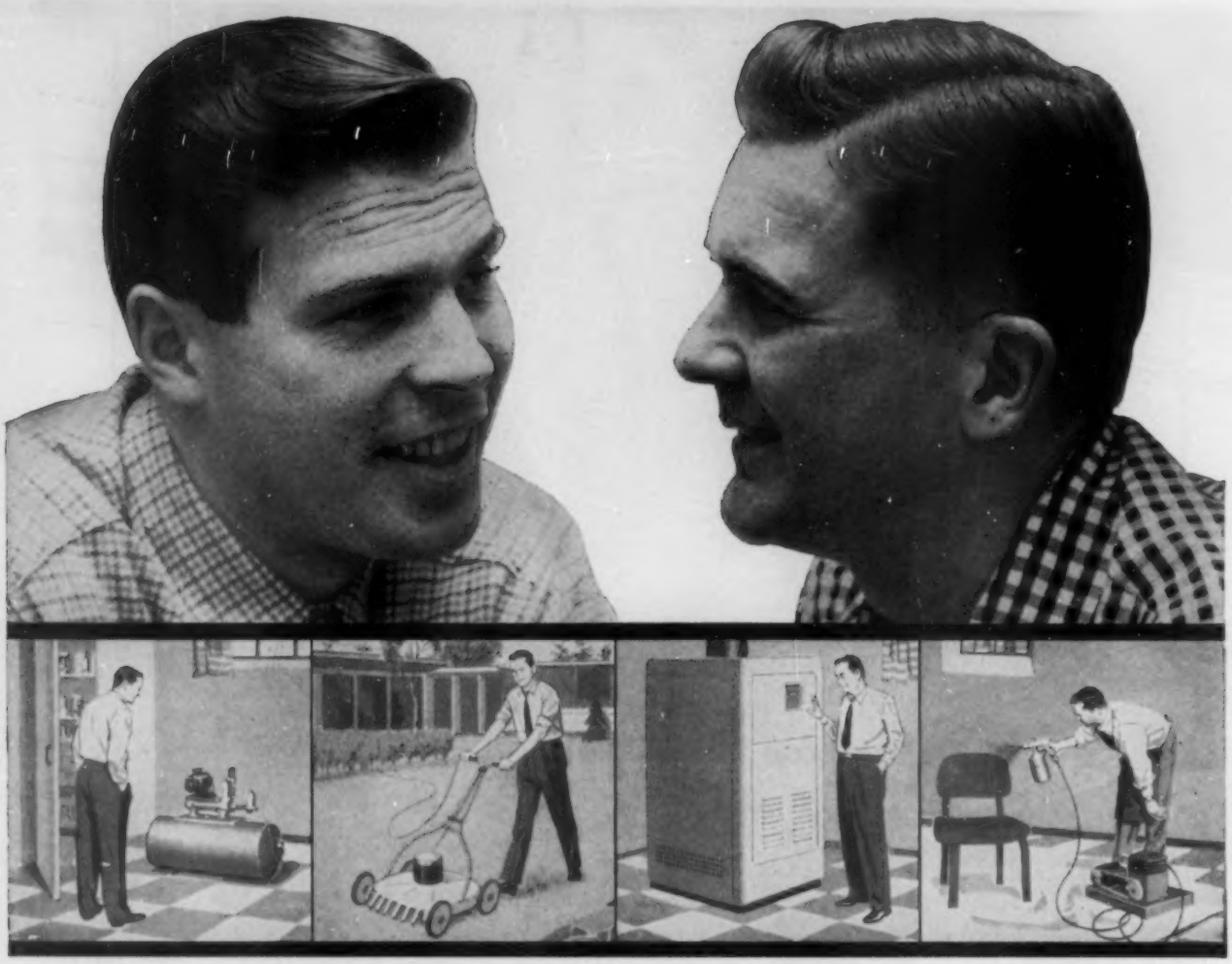
☐ *Send bulletin showing how I can take advantage of the new "Formica-4" laminated plastics service.*

Name_____

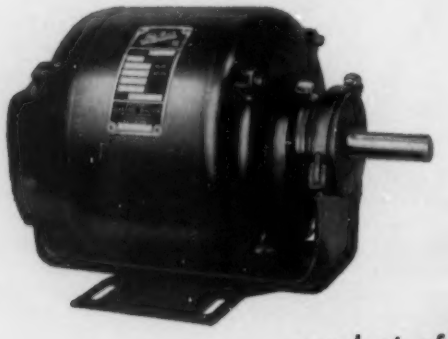
Company _____ Title _____

Address_____

City _____ Zone___ State_____



Satisfied Customers sell new customers...



Look at this man. He's telling a neighbor why he's so pleased with his motor driven appliances. He—a satisfied customer—is just about the best salesman a product can have! One *big* reason for his satisfaction—even though he may not know it—is the Packard Electric motors that power his appliances.

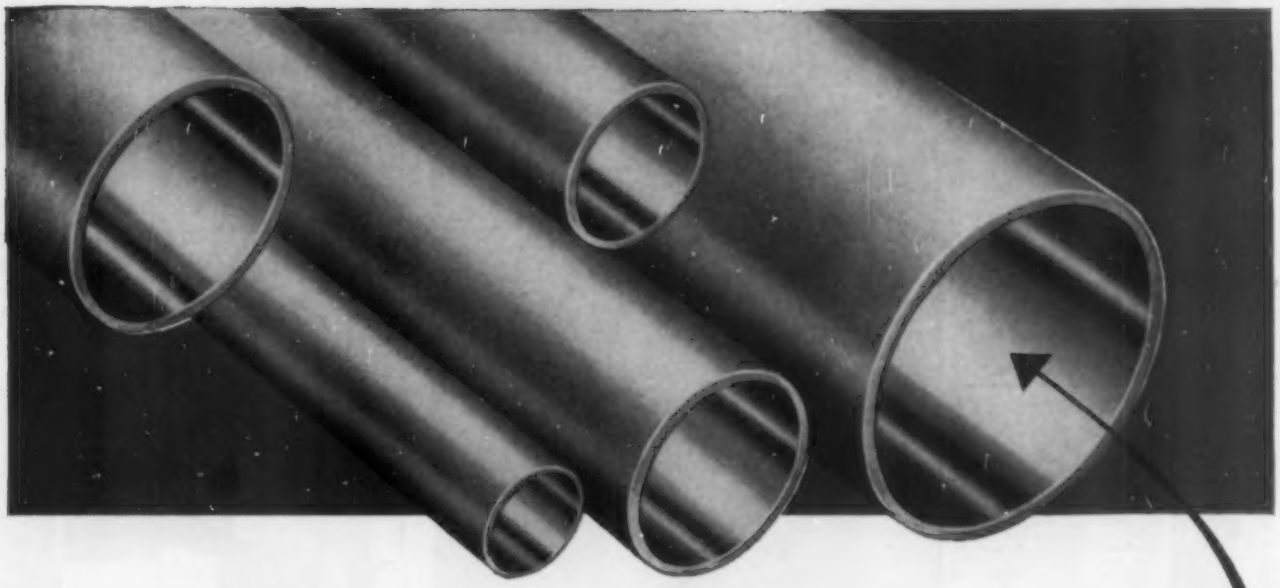
Packard fractional horsepower electric motors have been making satisfied customers for 38 years—because a Packard motor does its job longer, quieter, with less maintenance cost. The appliance maker who standardizes on Packard Electric motors gives his product that extra touch of dependability that builds sales.

product of GM GENERAL MOTORS *General Motors*

Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division, General Motors, Warren, Ohio



J&L cold drawn ELECTRICWELD tubing now available with a superior SPECIAL SMOOTH I.D. finish

Reduces your over-all production costs in applications like these . . .

- **cylinder tubing**
- **hydraulic and pressure tubing**
- **shock absorbers**
- **ordnance components**

This new drawn-over-mandrel grade tubing with its mirror-like inside surface finish is today busy helping manufacturers reduce or entirely eliminate costly machining on many applications and is being substituted for more costly types of steel tubing. For example, it may be used, without inside honing, for many cylinders through which plungers are passed.

J & L Cold Drawn ELECTRICWELD Tubing with a *Special Smooth* ID finish combines the physical advantages imparted by today's modern electric welding techniques with those of cold working. It withstands high internal hydrostatic pressures, carries heavy torsion loads, resists high-frequency vibration, and offers a favorable weight-to-strength ratio for applications in which loading occurs in all directions.

J & L Cold Drawn ELECTRICWELD Tubing can be furnished in its three specifications in OD sizes from ¾-inch to 2¼ inches and in wall thickness from 20 to 10 gage, 0.035 and 0.134-inch respectively.

This new booklet provides the information you need . . . specifications . . . tolerances . . . chemistry . . . mechanical properties . . . annealing . . . finishes.

J&L STEEL

Jones & Laughlin
STEEL CORPORATION — *Pittsburgh*

Send for your free copy today!

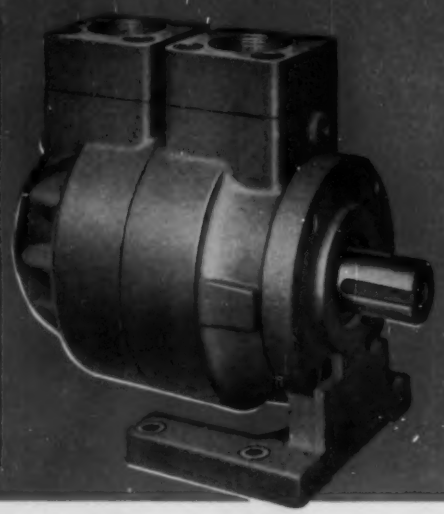
Jones & Laughlin Steel Corporation
Dept. 409, 3 Gateway Center, Pittsburgh 30, Pa.
Send me a copy of your new Cold Drawn ELECTRICWELD booklet.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____

Brute Strength or Delicate Handling of Rotary Power Functions • • •

TWO VANES ARE BETTER THAN ONE

The hydraulically balanced DUAL-VANES in DUDCO Fluid Motors, as contrasted with conventional designs, maintain MULTIPLE AREAS OF CONTACT ON THE CAM RING . . . doubling the number of effective barriers to slippage and power loss. This patented principle is an exclusive DUDCO feature!



DUDCO
FLUID MOTORS

Compact and sturdy, DUDCO DUAL-VANE Fluid Motors operate quietly and smoothly under the most strenuous conditions. They're built to "take it" . . . frequent reversals, rapid accelerations or stalling under load. With DUDCO you get the big advantage of 2000 psi operation at a cost comparable with that of lower pressure equipment.

DUDCO is a big, exciting story for every hydraulics engineer because . . . power losses are minimized and operating efficiency is higher . . . starting torques are high . . . operation is smooth, quiet and exceptionally free from wear or maintenance problems.

On Conveyor systems for agricultural, food processing, mining and other industries, DUDCO DUAL-VANE Fluid Motors provide the extras in performance that save time, money and labor. Operating

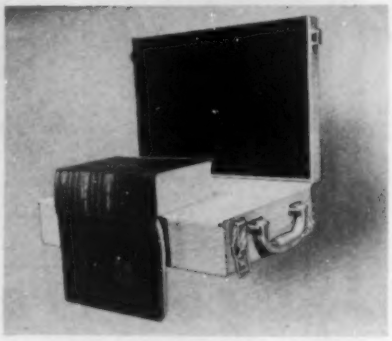
the winches on a giant tank retriever and other large mobile equipment calls for high starting torque and the dependable power of DUDCO DUAL-VANE MOTORS.

Write for Bulletin DM-301 fully describing DUDCO DUAL-VANE Fluid Motors today!

DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

components in service or laboratory testing of dielectrical materials up to 15,000 v, dc. The complete set measures 14 x 9 x 8 in. and weighs less than 25 lb. Lintronic Ltd., 32 Lockwood Terrace, W. Hartford 7, Conn.

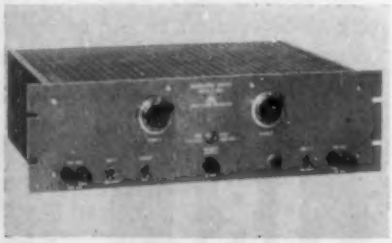
For more information—
Circle 103, inside back cover



Portable Photocopier

This photocopying unit fits into a briefcase. Anything written, printed, typed, drawn or photographed—from color or black-and-white originals—can be exposed by placing the original in the photocopier with a sheet of sensitized paper and simply flipping the switch. The 9½ x 14¾ in. copying surface copies up to legal size paper. A special storage compartment within the printer protects exposed negatives until they can be developed. The unit weighs 12½ lb and operates on either ac or dc. Copease Corp., 270 Park Ave., New York 17, N. Y.

For more information—
Circle 104, inside back cover



Transistor Power Supply

This is a regulated, dual-voltage supply, with both outputs contained in a single chassis suitable for rack mounting or bench use. Cabinet size: 5¼ x 19 x 14 in. deep. Each output supplies 0-100 v, dc, continuously variable (without switching), and

(Continued on page 343)

Engineering Equipment

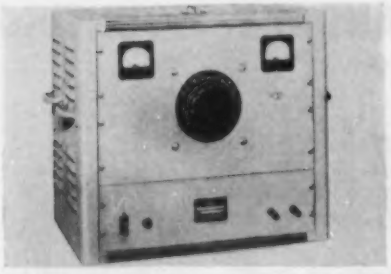
0-100 ma max. No derating of output current is necessary. Voltage is adjustable to 1/10 v variations. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.

For more information—
Circle 105, inside back cover

Micro Storage Containers

This storage set is intended to help keep in order various lots of small parts and small quantities of materials. Each set of 20 containers is enclosed in a clear plastic box with hinged top. A set is smaller than the palm of hand. Containers are of frosted glass, each with transparent cover. The containers are 13 mm dia, and are furnished either 13 or 7 mm high. Twelve sets, providing containers for 240 lots of material, are furnished on one flat tray. The individual containers can be marked with pencil and the marks easily erased when desired. R. P. Cargille Laboratories, Inc., 117 Liberty St., New York 6, N. Y.

For more information—
Circle 106, inside back cover

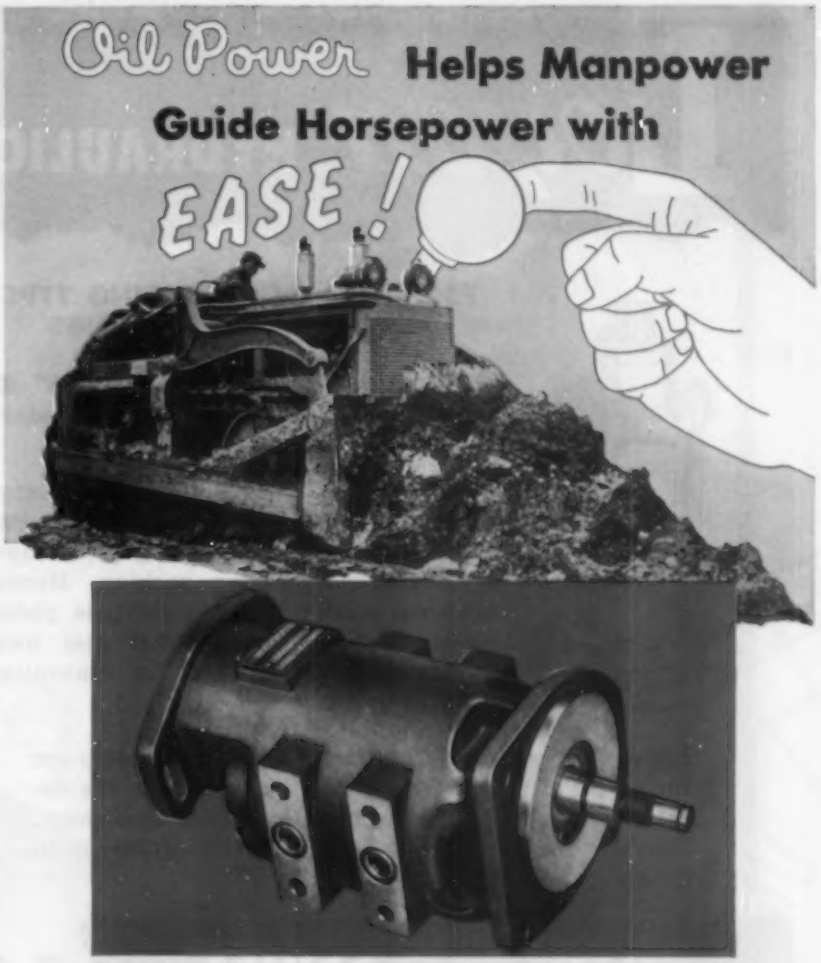


Filtered D-c Power Supply

This power supply is for continuously variable 0 to 125 v at all loads up to 10 amp. Intermittent loads up to 20 amp can be obtained. A-c hum or ripple is less than 1 per cent at 10 amp.

Special forced air cooling is said to increase the margin of operational safety, give longer rectifier life and greater current carrying capacity. This universal power supply is asserted to service and operate practically all industrial d-c equipment from a-c lines. Completely variable voltage makes it possible to test all equipment under almost any voltage input condition. Dimensions: 19½ x 22 x 17 in. Electro Products Laboratories, 4501 N. Ravenswood Ave., Chicago 40.

For more information—
Circle 107, inside back cover



Arm-weary tractor operators are grateful for TD-14A and TD-18A International Harvester crawlers. They steer with the ease of a late model car for each track is controlled by its own hydraulic circuit...a booster system with velvet smooth, positive action that stems from

HYDRECO
Oil Power

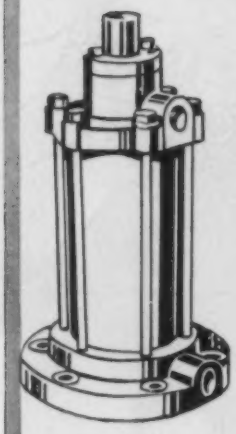
Here is a HYDRECO dual pump that delivers 5 gpm to each circuit at 1200 rpm against a system pressure of 700 psi. The dual pump provides a circuit for each track and the result . . . no arm-weary operators . . . more accomplished with less effort, in less time . . . smoother, higher performance . . . lower maintenance.

For engineers seeking practical answers to problems of trouble-free hydraulic controls, better performance, added functions and greater sales appeal for mobile equipment, the experience of HYDRECO engineers offers a definite answer!

WRITE— *for latest literature and full information on new developments in HYDRECO Pumps, Motors, Valves, and Cylinders.*

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1112 EAST 222nd STREET • CLEVELAND 17 • OHIO
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

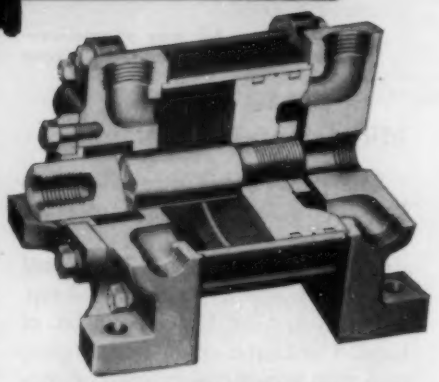
Logan HYDRAULIC CYLINDERS



750 SERIES NONROTATING TYPE
7 STANDARD MOUNTINGS

Eight standard sizes from 2" to 8" diameter bore. Maximum operating pressure 750 psi.

Covers chrome nickel cast iron. Large outlet and inlet for rapid action. Bronze packing glands. Steel packing gland caps. Hydraulic-type V-ring packing. Honed, seamless steel tube. Step cut-type piston rings. Piston chrome nickel cast iron. Multiple pipe connections for convenient installation.



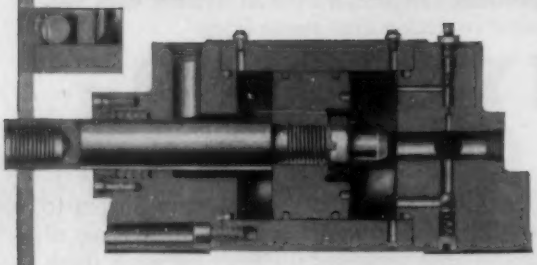
Check the many outstanding features of the Logan hydraulic double-acting, nonrotating-type cylinder as indicated in the above cross-section. They assure continuous service under most severe operating conditions.

Logan 750 Series and Rotating Hydraulic Cylinders are the result of nearly forty years' experience in the development and manufacture of hydraulic equipment. They are today providing high operating efficiency in thousands of plants.

ROTATING "HR" TYPE

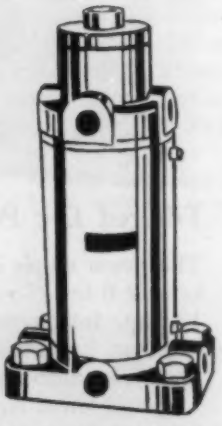
Seven standard sizes from 3" to 14" diameter bore. Maximum operating pressure 500 psi.

ROTOCAST® SERIES . . . . 7 STANDARD MOUNTINGS



Sizes from 2" to 8" bore; any length stroke up to 8 feet as standard. Four piston rod end types. Operating pressures to 1500 psi.

Note features as shown in cross-section. Ground and polished alloy steel piston rod. Bronze packing gland bushing. Self-adjusting hydraulic packing. Synthetic seal rings (see enlargement). Close-fitting pilot for centering piston on piston ring. Nut securely locked to prevent loosening of piston. Close-grained cast piston of ample length to provide necessary bearing and strength. Cushion check valve of ample size to prevent quick start of piston travel. Optional ports. Adjustable cushion speed valve. Automotive-type piston rings. Air vent valves. Centrifugally cast iron cylinder tube retains smooth, accurate bore. Large ports for unrestricted oil flow. There are no hydraulic cylinders more dependable than Logan Rotocast.



Let Logan engineers help you design your Air and Hydraulic Circuits.

MEMBER—
National Machine Tool Builders Assn.
National Fluid Power Assn.

LOGAN MANUFACTURES 7023 STANDARD CATALOGED ITEMS

FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3
AIR and HYDRAULIC PRESSES, Cat. 51 • COLLET GRIP TUBE FITTINGS, Cat. 200-5 • HYDRAULIC CONTROL VALVES, Cat. 200-4
HYDRAULIC CYLINDERS, Cats. 200-2; 200-3 • HYDRAULIC POWER UNITS, Cat. 200-1 • SURE-FLOW COOLANT PUMPS, Cat. 62

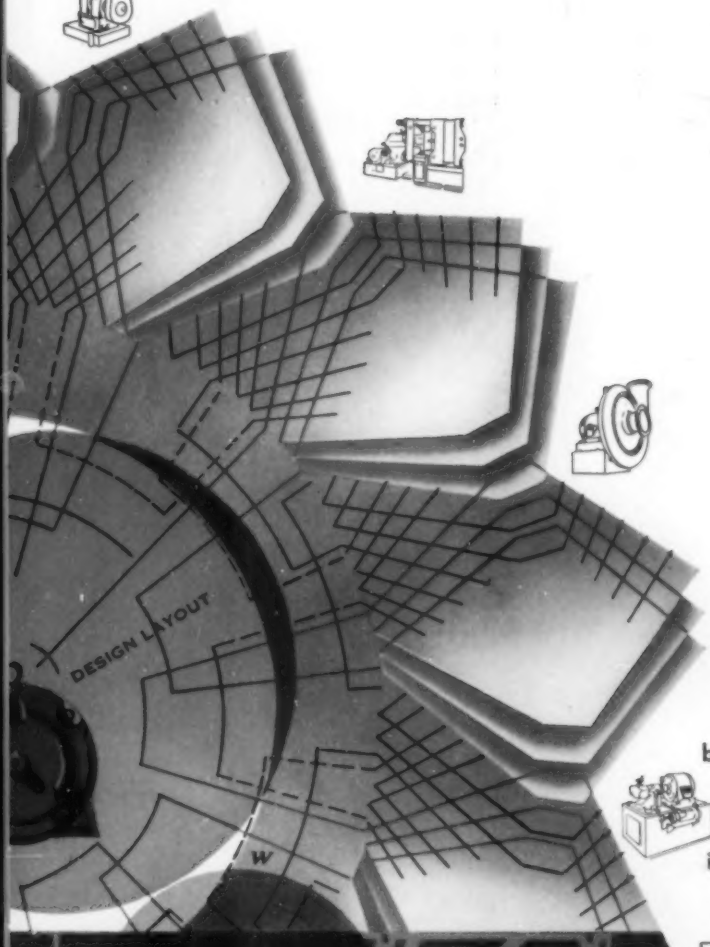
SAVES TIME — Logan AIR AND HYDRAULIC EQUIPMENT — EFFORT • MOTION

LOGANSPORT MACHINE CO., INC., 812 CENTER AVE., LOGANSPORT, IND.

THE MARK OF AN EXTRA DEPENDABLE MACHINE

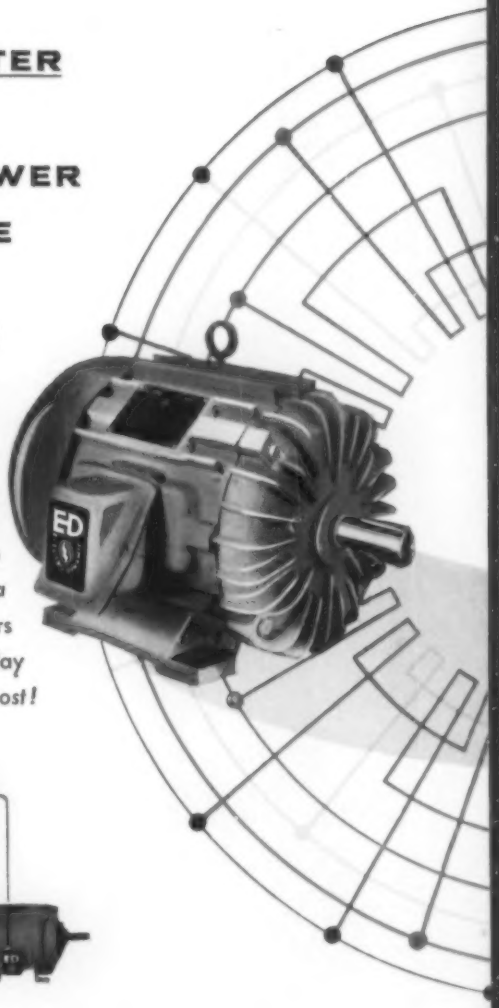
ED ELECTRO DYNAMIC

75TH ANNIVERSARY 1880 — 1955

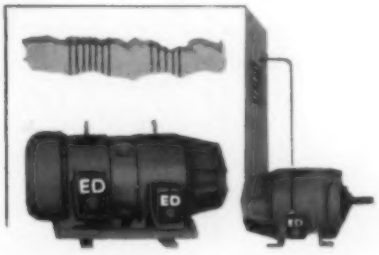


A BETTER KIND OF POWER PACKAGE

Extra starting and anti-stalling capacity. Extra cool, extra quiet operation. Achieved without sacrifice of full-load efficiency. Backed by unparalleled experience E. D. motors are *extra dependable*...75 years in the making...yours today *at no extra cost!*



"Selectrol" Variable Speed Drives for *extra dependable* automation.



Gear-ED-motors offer a wide choice of speeds.

ELECTRO DYNAMIC

Extra dependable motors

PRODUCT OF GENERAL DYNAMICS

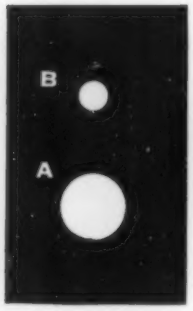
GD | ED | EB | GA | C-L | C-V

1500

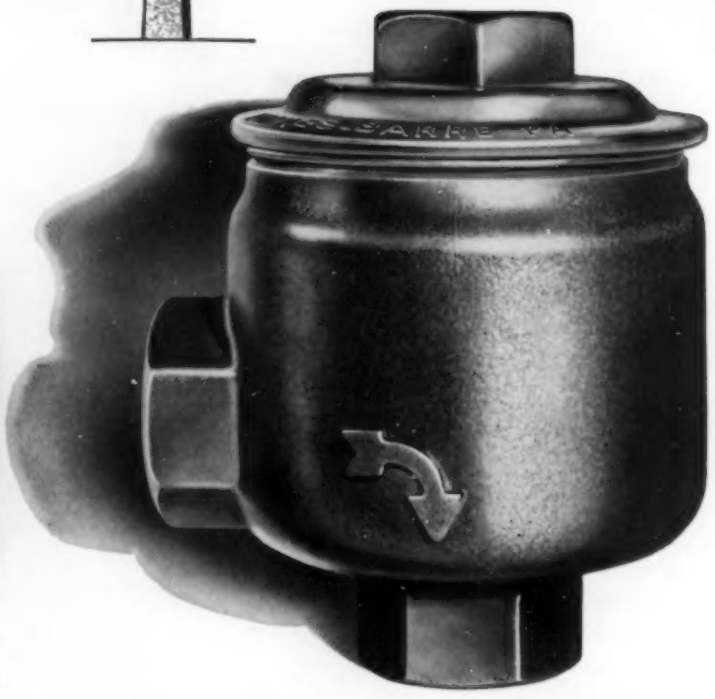
Write for literature to: **ELECTRO DYNAMIC** DIVISION OF GENERAL DYNAMICS CORPORATION, BAYONNE, N. J.

TALK ABOUT

Capacity



Discharge orifice of 1" NICHOLSON trap (A) compared with other types of same size (B). Nicholson's greater—in every size!



Compare capacity of a Nicholson Steam Trap with any other trap of same size. Greater capacity—right across the board—means Nicholson Industrial Traps discharge condensate and air from steam lines and process equipment *faster*, more *effectively*. In toughest steam-using equipment service, Nicholson's pay off 4 ways:

- **lower initial cost—more for the money**
- **less upkeep expense—minor maintenance**
- **faster warmup—high, even temperatures**
- **faster production—increased 20% to 30%**

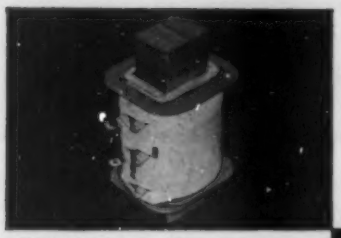
Where performance counts, specify Nicholson. Write for *Catalog 953*.

NICHOLSON

W. H. NICHOLSON and Company

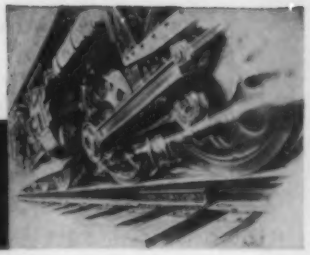
TRAPS • VALVES • FLOATS • METAL PARTITIONS

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 58 PRINCIPAL CITIES



DIELECTRIC STRENGTH. National Vulcanized Fibre gives electrical parts high dielectric strength—plus toughness and excellent forming properties. Has ideal application as insulation.

NATIONAL VULCANIZED FIBRE



DURABLE—TOUGH—RUGGED. National Vulcanized Fibre rail joint insulation withstands years of continuous exposure and heavy pounding of today's high-speed railroading. Will not corrode or deteriorate.

ARC RESISTANCE. In circuit breakers, National Vulcanized Fibre safely curbs electrical arcing without carbonizing or tracking. Easy to bend, punch and form. Light in weight. Heat-and-shock resistant.

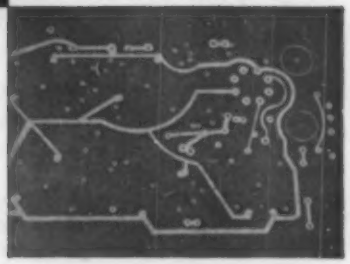
FOR MEN WITH IMAGINATION . . .

two materials of unlimited application

MACHINABILITY—MECHANICAL STRENGTH. New paper-base Phenolite not only has excellent arc resistance, but superior machining qualities as well. Great compressive and tensile strength.

PHENOLITE Laminated PLASTIC

CHEMICAL RESISTANCE. Chemical-resisting grades of Phenolite are unaffected by most corrosive fluids and atmospheres. Retain high strength, resiliency and dimensional stability.



COMPACT DESIGN—ECONOMY—HIGH TEMPERATURE RESISTANCE. Printed circuits made of copper-clad Phenolite permit compact design, simplify production, reduce assembly time.

Here are six ideas to spur your imagination. They only *suggest* the many things that can be done with National Vulcanized Fibre or Phenolite Laminated Plastic.

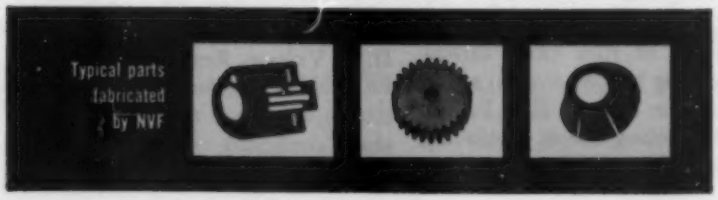
The full list of current uses for these materials would more than fill this page and many more pages! Yet more are coming up almost every day. For NVF is not only the world's largest producer of vulcanized fibre. We also make a fulltime job of thinking up new improvements to our products—and new ways of using them to improve *yours*. Result: designers call our materials the most versatile ever.

Looking for an easy, economical way to improve production—or products? Team up with NVF. We're prepared to assist you all the way from initial design to the delivery of precision fabricated parts. Our new 16-page Catalog will give you full information about our products and services. Write for it on your business letterhead to Dept. B-11.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

Also Manufacturers of Peerless Insulation, Materials Handling Receptacles, Vul-Cot Wastebaskets and Textile Bobbins.



I'M A TOUGH BUYER

BUT GARRETT'S GOT IT FOR QUALITY

No sir, *you can't beat Garrett* when it comes to top quality in small parts. Their "statistical quality control system" means every shipment you get is the finest. But quality is only part of what I like about Garrett. They manufacture and stock the world's most complete line of washers and hose clamps. Boy, when you need any kind of a lock washer, flat washer, spring washer or hose clamp you get it fast . . . most everything right out of stock.

When it comes to stampings and assemblies that's where their high-speed automatic equipment stars. Turns out exactly what you want in no time at all.

Sure, I'm a tough buyer. I want the best. I want it fast. I want it priced right. And Garrett is the place for me.

LOCK WASHERS
FLAT WASHERS
HOSE CLAMPS
STAMPINGS

Manufactured by

GEORGE K. GARRETT CO., Inc.
Philadelphia 34, Pa.

Garrett
OF PHILADELPHIA

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Cold-Drawn Steels–Booklet 672, 32 pp, summarizes properties and applications of typical grades of cold drawn carbon steels, free machining steels, stress-relieved steels, leaded and alloy steels and stainless steel. Republic Steel Corp., 3100 E. 45 St., Cleveland 27, Ohio.

Circle 108, inside back cover

Rotating Mechanical Seals–Bulletin MS954, 8 pp, describes design and operating features, seal pressure and temperature ratings, sizes and dimensions, provisions for handling suspended solids, vacuum service, and installation procedure for either screwed or flanged bonnets. United States Gasket Co., Camden 1, N. J.

Circle 109, inside back cover

Plastics Extrusion and Molding–Bulletin, 8pp. Photographs show laboratory control and molding processes along with variety of compression molded and extruded parts. Also included are ASTM compounds and characteristics, including natural rubber, GRS, buna-N, neoprene, and butyl. Geauga Industries, Middlefield, Ohio.

Circle 110, inside back cover

Rotary Pumps–Catalog Bx, 28 pp, has data on general purpose pump models, capacities from ½ to 1050 gpm. Viking Pump Co., Cedar Falls, Iowa.

Circle 111, inside back cover

Elapsed Time Indicator–Bulletin 5, 2 pp, describes hermetically sealed 10,000 hr indicators available for operation on 115 v, 60 cps, ac. Haydon Mfg. Co., Inc., Torrington, Conn.

Circle 112, inside back cover

Ferrous Metallurgy–Chart (8½ x 11 in., black and white) gives principal characteristics of steel (with carbon content ranging to 0.9 per cent) across the temperature range to 2900 F. The important working zones, including preheating for welding, stress relieving, normalizing, annealing, and forging are shown. At the right of the chart 24 common metallurgical terms are defined and explained. A diagram symbolizing the change in grain size with temperature appears at left. Tempil Corp., 132 W. 22 St., New York 11.

Circle 113, inside back cover

Adjustable Speed Drive – Bulletin 1100-B, 7 pp, describes drive for use on ac with magnetic amplifier control. Louis Allis Co., Milwaukee 7, Wis.

Circle 114, inside back cover

Mica Insulation–Catalog M55, 14 pp, describes fabrication, range of sizes and shapes of mica paper, segments, tapes, tubing. Continental-Diamond Fibre Div., Budd Co., Inc., Newark, Del.

Circle 115, inside back cover

Forgings, Drafting Standard–Copies of manual of proposed drafting standard for forging is available for those interested in criticizing and commenting. American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y.

Circle 116, inside back cover

Ceramic Magnets–Catalog 15, 4 pp, describes a light-weight, non-metallic ceramic permanent magnet. Manufacturing processes involved and types of magnets available included. Indiana Steel Products Co., Valparaiso, Ind.

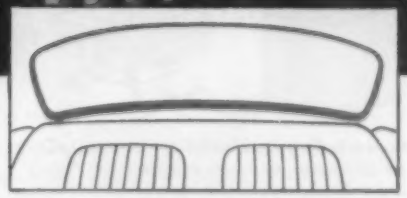
Circle 117, inside back cover

Boron Carbon Resistors–Bulletin B-6a, 4pp, gives types, construction, applications, performance, temperature coefficient, tolerance, insulation, termination. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 118, inside back cover

High Voltage Resistors–Bulletin G-1a, 8pp, has specifications, installation, tolerance, voltage coefficient, temperature coefficient, ratings, insulation,

(Continued on page 353)



Dodge selects Enjay Butyl rubber for big rear-window weatherstrip

Super-durable Enjay Butyl fits perfectly Dodge's rigid specifications for its rear-window weatherstrip. Under the toughest conditions of weather and use, Enjay Butyl parts stay like new, help add style and color to new cars. In fact, some automobiles have more than 100 parts made of this fabulous rubber.

The many advantages of Enjay Butyl make it the almost perfect rubber for the automotive industry. Its price and ready availability are advantages, too. And it is now available in non-staining grades for *white* and *light-colored* parts. For full information and for skilled technical assistance in the uses of Enjay Butyl, contact the Enjay Company at either of the addresses below.

ENJAY **ENJAY COMPANY, INC.,** 15 West 51st Street, New York 19, N. Y.
District Office: 11 South Portage Path, Akron 8, Ohio.

ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

35 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

TAYLOR Laminated Plastics Vulcanized Fibre

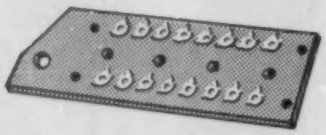
Shop Talk

TAYLOR FIBRE CO.

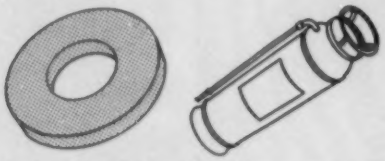
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

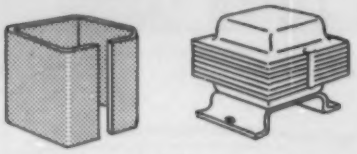
Tips for designers



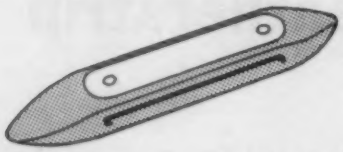
Terminal board for a complex circuit in an electronic spectrophotometer instrument is made of Taylor Grade LE laminate . . . selected for its insulating and mechanical properties.



Washers for fire extinguishers are punched from Taylor Vulcanized Fibre . . . a versatile material that resists many chemicals, provides a long-wearing seal.



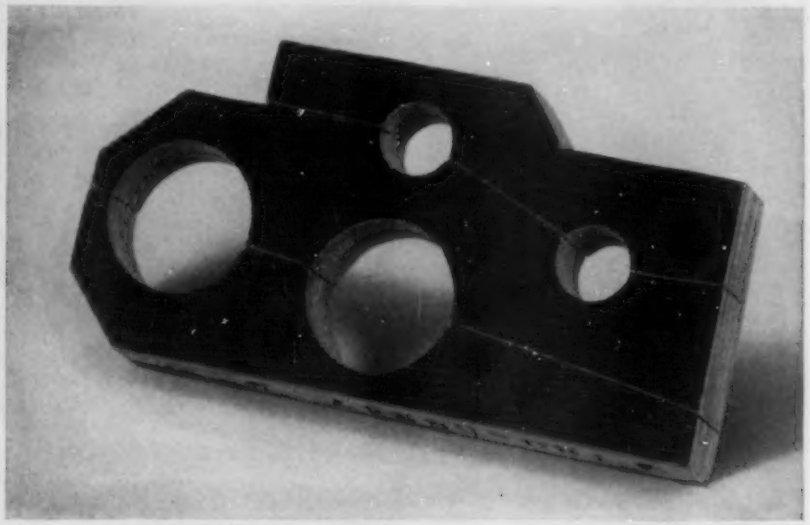
Inter-winding insulation for transformers is an application for Taylor Insulation (Fish Paper) . . . a tough, economical material that resists abrasion, withstands high voltages.



Textile shuttles are faced with Taylor shuttle fibre, which machines to a smooth, long-wearing surface that doesn't snag yarn in high-speed machines.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Multiple fuel line clamp, for use in the North American F-86 Sabrejet fighter plane, is made of Taylor fabric base laminate . . . chosen for its mechanical strength, light weight and resistance to extremes of temperature and humidity.

Strength and machinability highlight Taylor fabric base laminates

Does your product design call for a material with high strength, light weight, stability, electrical resistance and electrical insulation qualities . . . plus good machinability?

Consider what Taylor fabric base phenol laminates can do for you. This family of versatile materials covers a broad range of mechanical, electrical and machining properties, from which you'll probably find the exact combination that fits your requirements. The fabric base may be cotton—in various weights and weaves—asbestos, glass or nylon fibre, bonded by selected high grade Taylor resins.

Need mechanical strength? Choose Grade C for toughness, resilience, resistance to impact and fatigue . . . or Grade L for comparable qualities with better machined edges.

Need electrical insulation? Grade CE combines mechanical strength with good electrical insulation properties . . . Grade LE for somewhat higher stability and insulating value . . . and Grade CEF offers a finer machined appearance with good impact and electrical strength.

Need dimensional stability? Grades CE-6 and LE-6 combine many C and L qualities with greater dimensional stability . . . particularly valuable in close tolerance work.

Need to deep-draw? Grade C-7 is made with a special fabric designed for post-forming qualities . . . draws and stretches during forming into complex shapes.

High temperatures? Grade AA asbestos base, and Grade G-3 glass fabric base give you a choice of materials that stand up at elevated temperatures.

These and other Taylor fabric base phenol laminates can serve you well, by putting extra performance values into the products you manufacture, and by providing economical machining in your production line. For complete details, write for a copy of Taylor's general catalog. And ask a Taylor specialist to consult on your specific materials application problem.

LINEAR

roto-molded

"O" rings

quality and quantity

— in a hurry!

Today, there's only one *best* way to order "O" Rings, and get true compression—molded quality, mass-produced, delivered in a hurry, in quantities to satisfy anyone's needs!

LINEAR, with an exclusive high-speed process, produces ROTO-MOLDED "O" Rings with precise tolerances, absolute uniformity, flash-free surface and pre-stretched grain structure—at prices that command consideration.

Regardless of the compound used, the ROTO-MOLDING process with its scientific cure control, produces "O" Rings of improved physicals.

LINEAR ROTO-MOLDED perfect circle "O" Rings are produced in a variety of standard sizes and materials, plus special types and sizes for specific applications.

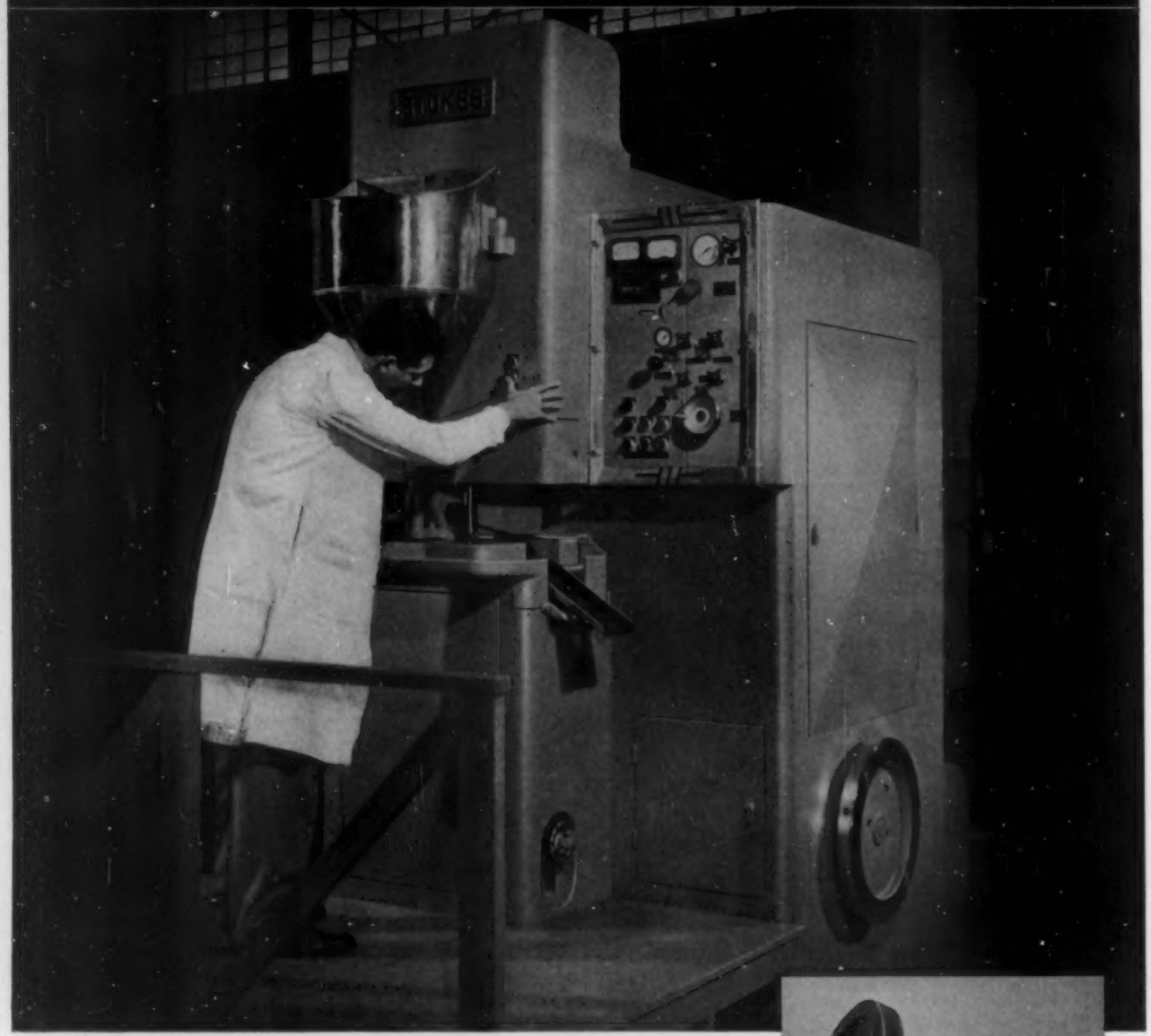
Write or call Linear today for the facts!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

NEW versatile STOKES powder metal press



A new 50-ton multiple-motion press offers increased economy to powder metal molders

Here is a powder metal press so new, so radically different from anything in the field today that it presents entirely new possibilities for efficient industrial compacting. With its simplified tooling and fast operation, the 640 press outdates all other designs; makes possible the application of powder metal to the production of parts for which the process has never before been considered economical.

The Stokes Model 640 is a completely new design, based on an intimate knowledge of the industry's requirements. It represents the latest achievement in Stokes 35-year experience in the design and manufacture of presses specifically for powder metallurgy.

For example, the 640 press is the first to give full, *50-ton simultaneous breakaway* on multiple lower punches, important in successful ejection of complex parts; *centralized controls*, for easy, fast set-up and operation; *independent adjustments* of all press actions while the machine is running; *direct-reading handwheel calibrations*, that eliminate guess-work on settings, permit exact records for each piece produced.

If you are now compacting powdered metals or are investigating how this economical process can be applied to your production, you should know about the many exclusive features of the Stokes Model 640 press. Write for Bulletin 670.

F. J. Stokes Machine Company
Philadelphia 20, Pa.

The pieces shown are typical of parts for which the Model 640 press is particularly well suited. Difficult parts like these and pieces with double hubs, multiple levels and thin flanges all can now be made economically on the Stokes Model 640 press.

STOKES

OFFICES IN PRINCIPAL CITIES,
REPRESENTATIVES THROUGHOUT THE WORLD

terminations. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 119, inside back cover

Wire-Wound Resistors—Catalog R2, 8pp, contains an alloy characteristics chart listing symbols, alloys, trade names, nominal temperature coefficients, thermal emf on copper, and a guide to proper selection. Precision, Inc., 730 Lyndale Ave., N., Minneapolis, Minn.

Circle 120, inside back cover

Vacuum-Melted Metals and Alloys—Bulletin VM-101, 23 pp, covers effects of vacuum melting on properties of various metallic materials, benefits of the process to the user of such metals and fabricating and machining recommendations. General Electric Co., Detroit 32, Michigan

Circle 121, inside back cover

Miniature Pressure Transducers—Bulletin MPT-1, 9pp, describes transducers for absolute, differential and gage pressures. Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 122, inside back cover

Right-Angle Speed Reducers—Bulletin 5503, 47 pp, contains data and information on spiral bevel-helical gear type speed reducers. Western Gear Works., P.O. Box 182, Lynwood, Calif.

Circle 123, inside back cover

Magnetic Pulleys — Bulletin 303C, 14pp, includes specifications on magnetic pulleys and pulley separators. Stearns Magnetic, Inc., Milwaukee 46, Wis.

Circle 124, inside back cover

Variable Speed Transmission — Bulletin, 7 pp, describes design and selection of types of pulley-based transmissions. Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, Calif.

Circle 125, inside back cover

Angular Contact Bearings—Catalog, 11 pp, describes line of bearings also known as the cup type, with examples of applications, tables of dimensions, load ratings, cross-section drawings. Also describes line of miniature bear-

(Continued on page 356)

AN IMPORTANT

NEW CATALOG FOR YOUR FILES!

WINSMITH, Inc., 111 Eaton Street
Springville, (Erie County), N. Y.
Gentlemen: Please send me a copy of Catalog 155 on the new Series "C" Speed Reducers.

NAME TITLE

COMPANY

ADDRESS

CITY ZONE STATE

WINSMITH CATALOG 155
DESCRIBING THE NEW

"C" SERIES SPEED REDUCERS

Between the covers of this new catalog, every design engineer and speed reducer user will find the answer to how they can select speed reducers of more compact dimensions to achieve required output.

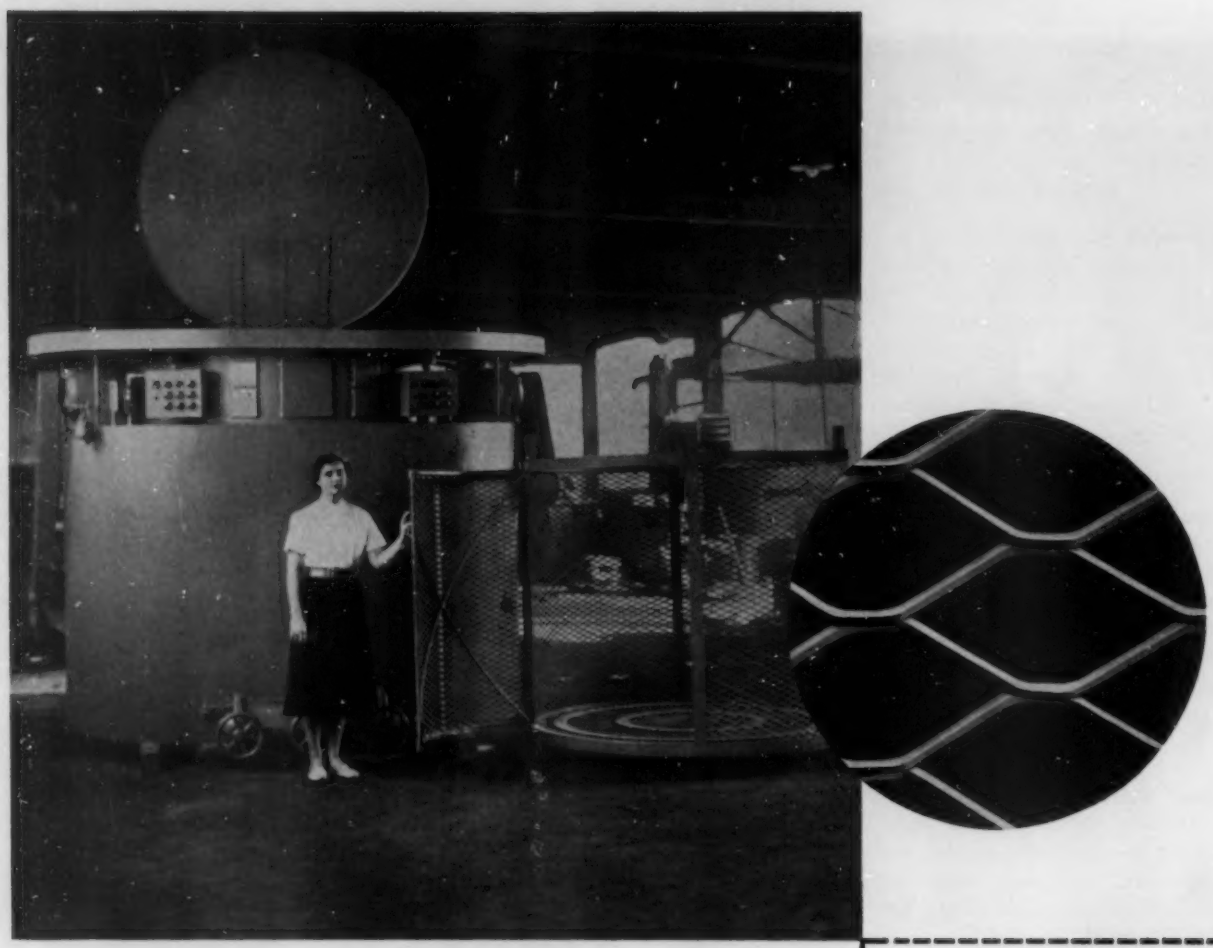
With this newly designed "C" Series, Winsmith has succeeded in increasing horsepower and torque output, and increasing the ruggedness of the units *without increasing overall size*. In all, 108 models in single and double reduction are available within the range of .01 to 34 hp; in a ratio range of 5:1 to 4460:1 and in an output torque range of 142 in. lbs. to 34,767 in. lbs. The complete "C" Series plus a number of other popular models in the Winsmith line are catalogued for your working convenience.

FOR YOUR COPY OF CATALOG 155 FILL IN AND MAIL THE COUPON TODAY!

WINSMITH SPEED REDUCERS

...a single source for the most complete line of speed reducers within the range of 1/100 h.p. to 85 h.p. in ratios of 1.1:1 to 50,000:1

WINSMITH, INC.
111 Eaton Street
Springville, (Erie County), N. Y.



How jet engines take a bath in an expanded metal basket

The J. P. "Whirlpool" industrial cleaner, shown above, cleans jet engines and parts at an Air Force base. Made by J. P. Manufacturing Co., of Youngstown, Ohio, the cleaner has an expanded metal basket with a two-ton capacity. A propeller and whirlpool circulate cleaning solution through the basket's mesh, searing off all deposits on metals being cleaned.

Penmetal expanded metal was ideal material from which to form the basket. Strong enough to take a two-ton load, yet with an open mesh, which permits free-circulation of the solution. It's low in cost, too.

Penmetal expanded metal is easily formed, shaped and welded. Comes in corrosion-resistant metals and carbon steel; large or small mesh; light or heavy gauge.

Can this versatile material turn *your* problem into a profit? Send for 28-page catalog, which suggests uses, and gives mesh sizes, weights and dimensions.

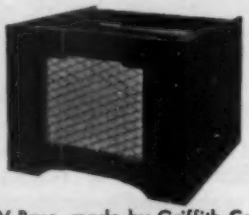
PENN METAL COMPANY, INC.

General Sales Office: 205 East 42nd Street, New York 17, N. Y.
District Sales Offices: Boston, New York, Philadelphia, Chicago, Detroit, Dallas, Seattle, San Francisco, Los Angeles, St. Louis

METAL MARK Penmetal 1869 OF QUALITY

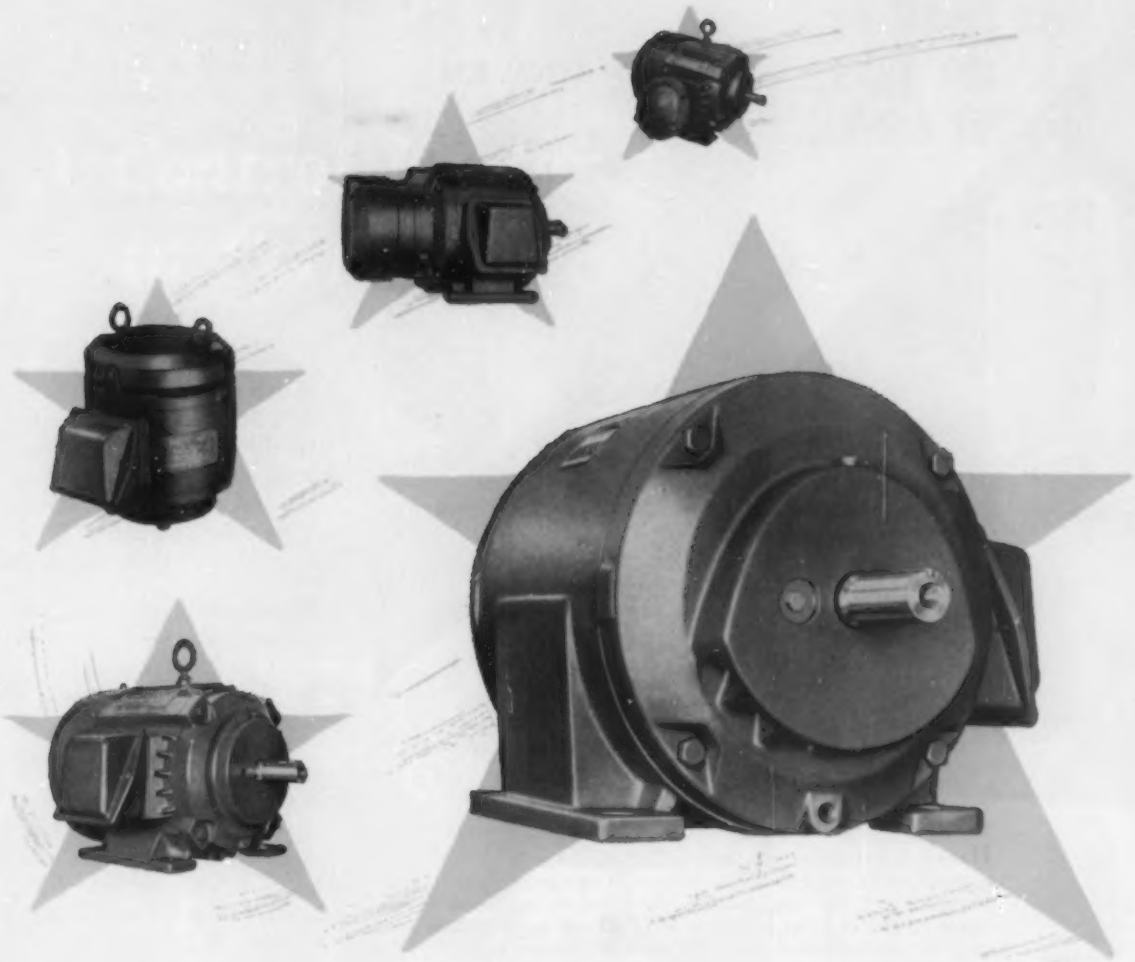
OTHER USES FOR EXPANDED METAL

Barbeque grill by Chattanooga Royal Company, Chattanooga, Tenn. Shelf is expanded metal.



TV Base, made by Griffith Co., Parkersburg, West Virginia. Front decoration of expanded metal.

PM-83



NEW *Totally Protected* MOTORS NOW AVAILABLE

Complete line of the NEW Reliance Totally-Protected A-c. Motors is IMMEDIATELY available.

These star performers combine maximum physical strength and protective enclosure. Starting and full load torques in excess of NEMA standards . . . built-in reserves to meet *extra* production loads.

Mount the new compact NEMA Frames where ever you have an application for an a-c. motor of 1 to 40 horsepower. All types of mountings . . . frame sizes 182 to 326-S.

Reliance Motors are *totally protected from core to cover* . . . rotating components and active material are carefully treated and assembled to assure a lifetime of trouble-free continuous performance.

Let us put these star performers to work for you—write for complete information. B-1008

RELIANCE ELECTRIC AND ENGINEERING CO.

Cleveland 10, Ohio • Offices in Principal Cities
Canadian Division: Welland, Ontario

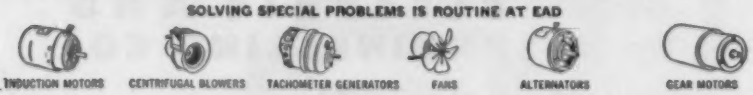
Here is the most compact centrifugal blower unit made . . . EAD's high-velocity subminiature centrifugal blower is only 2⅞" long, weighs only 6 ounces, yet it can move 13 cfm of air at a velocity of 3,000 feet per minute—and the volume holds up at high static pressures. It is driven by EAD's new one-inch diameter motor. The metal blower housing can be rotated to any position desired for maximum efficiency in cooling radar equipment, amplifier units, transmitter equipment, oscillators, and in other applications where high temperatures in confined areas demand miniaturized blowers with the highest possible performance characteristics. EAD's subminiature blower units meet all applicable MIL specification, and low temperature rise makes them suitable for high altitude and high ambient temperature operation.

CFM	13 @ 0" SP 10 @ 1.0" SP	7 @ 0" SP 5 @ .2" SP
MAX. SP.	2.5	0.6
RPM	20,000	11,000
AMPS	0.1	0.06
WATTS	10.0	6.0
CAPACITOR Mfd/Volts	0.25/220	0.1/220
WEIGHT (OUNCES)	6	6
MODEL NO.	B2GOU-C	B2HOU-C

Modifications of standard models or completely new designs can be engineered to meet your special cooling needs. Write for complete information.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



381 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE

ings. Landis & Gyr, Inc., 45 W. 45 St., New York 36, N. Y.

Circle 126, inside back cover

Graphite Pipe, Fittings – Catalog, 12pp, covers operating and dimensional specifications of diaphragm and custom-designed valves. Also contains a section entitled "Methods of Connection." Falls Industries, 31829 Aurora Rd., Solon, Ohio.

Circle 127, inside back cover

Sintered Metallic Oxides – Bulletin A-7, 7pp, describes properties of sintered metallic oxides for high temperature ceramics in mechanical, chemical and electrical applications. U. S. Stoneware Co., Akron 9, Ohio.

Circle 128, inside back cover

Springs–Brochure, 8pp, contains illustrated directions and other instructions for specifying springs. Automatic Spring Coiling Co., 4045 W. Thorndale Ave., Chicago, Ill.

Circle 129, inside back cover

Solenoid Valves – Bulletin V5003, 2pp, has flow diagrams of both single and dual solenoid valves. Dimensions and list prices are also given. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle 130, inside back cover

Drafting Room Furniture–Catalog, 16pp, includes tracing storage files, drafting tables, draftsman's stools and upholstered chairs. Frederic Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Circle 131, inside back cover

Relays–Data sheets (3) include resistance, capacity, dimensions, speed. Hedin Tele-Technical Corp., 87 Dorsa Avenue, Livingston, N. J.

Circle 132, inside back cover

Resistors–Catalog, 20pp, provides dimensional details, wattage ratings, maximum resistance and military equivalents. Cinema Engineering Co., 1100 Chestnut, Burbank, Calif.

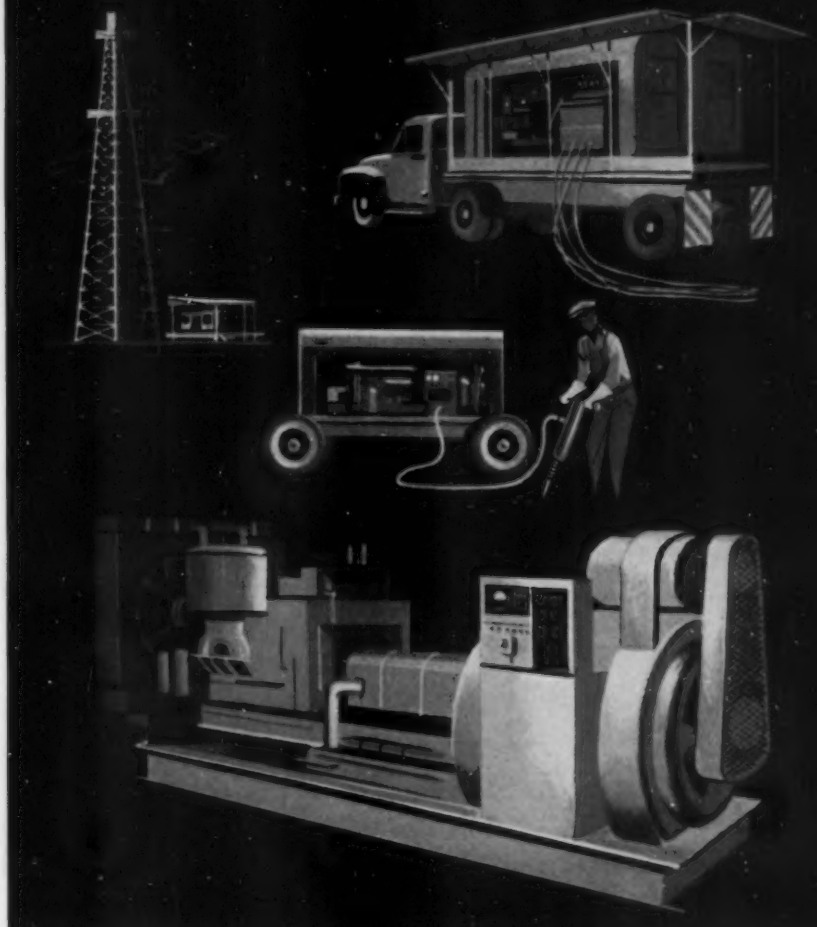
Circle 133, inside back cover

Titanium–Progress Report No. 2 includes tables giving the mechanical properties of both alloyed and unalloyed grades of the metal, and comparative properties of titanium and other pure metals. It discusses meth-

(Continued on page 360)

BEARINGS...

A Control Factor in Performance!



RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Here are industry's work horses . . . dependable diesel engines. They power trucks, tractors, construction equipment. As mobile units they bring light, power and compressed air to the job. As stationary units they light towns and villages. As stand-by units they provide emergency power and light. Their dependability is vital. To help assure this dependability we supply quality bearings for many sizes and types of diesels and are a major supplier to diesel engine builders. **FEDERAL-MOGUL DIVISION,** Federal-Mogul-Bower Bearings, Inc., Detroit 13, Michigan.

FEDERAL-MOGUL
DIVISION

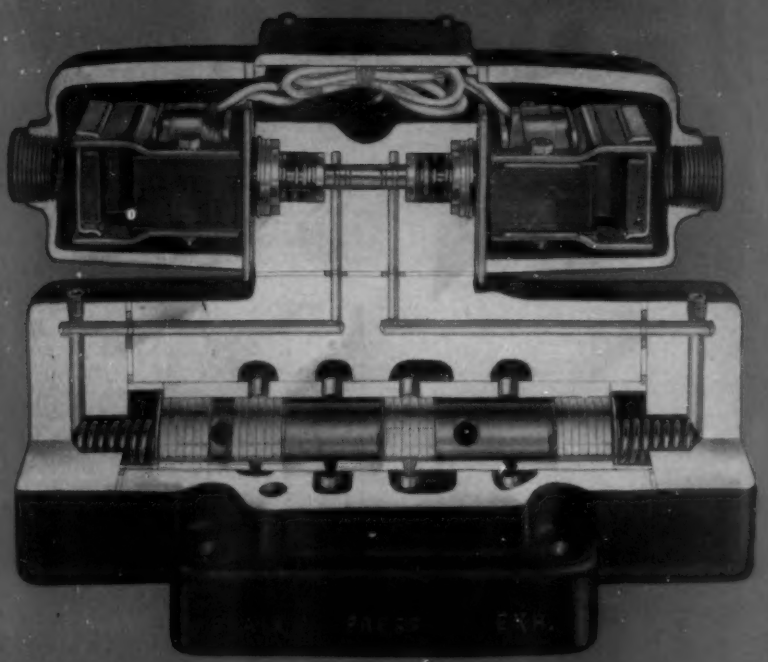
SINCE 1899

A product of CONTINUOUS RESEARCH and DEVELOPMENT

NEW RACINE

Twin Solenoid — Pilot Operated

4-WAY VALVE



Patent Applied For

Balanced Piston -- Sleeve Type -- 2000 psi Working Pressure

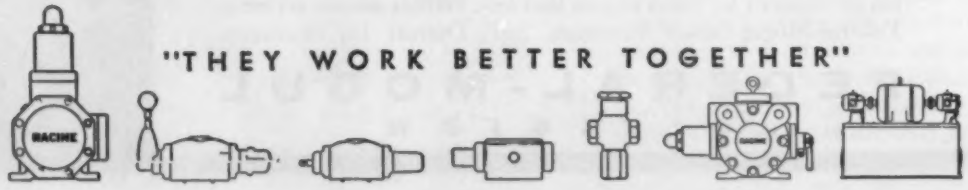
This design offers Solenoid Control, Pilot Operation, Subplate mounting, and allows unusual versatility with conversion to either spring centered, spring offset, or no spring. Solenoids are enclosed and secured to the valve in removable dust proof covers. Electrical operation is prevented when the covers are not in place. This feature promotes safety, and contributes to low maintenance.

Large openings permit a maximum flow of oil through the valve at a minimum pressure drop. This valve conforms to J. I. C. specifications and standards.

Write for catalog giving complete details and features. Address RACINE HYDRAULICS & MACHINERY, INC., 2072 Albert St., Racine, Wisconsin.

RACINE — STANDARD FOR QUALITY AND PRECISION — RACINE HYDRAULICS & MACHINERY, INC.

"THEY WORK BETTER TOGETHER"

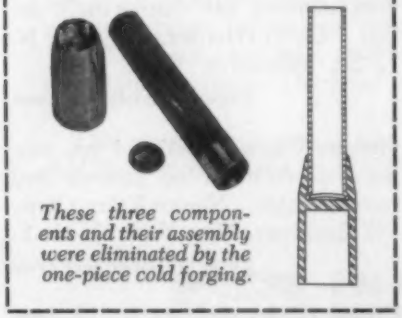


HUNTER DOUGLAS ONE-PIECE COLD FORGINGS

replace 3 piece unit, eliminate assembly, solve gas leakage problems!

A typical example of how Hunter Douglas cold forgings simplify everyday design problems

A most critical requirement in the production of an ordnance component was a perfect seal against the escape of high pressure gases. Fabrication by conventional procedures involved the assembly of three separate pieces—a screw machine part turned from bar stock and bored from each end; a separate sleeve machined from tubing, and a stamped Welsh plug. The three parts were unitized by expanding the Welsh plug within the sleeve, forcing walls into a machined groove within the head.



These three components and their assembly were eliminated by the one-piece cold forging.

To simplify the design, insure leak-proof construction and eliminate costly machining and assembly time, Hunter Douglas engineers suggested a cold forging from HD-11-T6, a high strength aluminum alloy.

All internal and external diameters of the cold forged component are now formed in a single, instantaneous press operation. No joints exist to cause leakage, consequently rejects are negligible. The cold forging, being highly stressed, easily withstands bursting pressures of 5500 psi without distortion. With its remarkable simplification in design, the cold forging requires fewer machining operations, thus saving both time and unnecessary metal waste.

Hunter Douglas Cold Forgings can be mass-produced in any required numbers and to cover a tremendous range of design requirements. If your components require *walls of zero draft, high physical properties, employ tubular shapes with or without a closed end, and must meet close dimensional tolerances,* HUNTER DOUGLAS COLD FORGINGS may provide the answer. Our engineers will give you a prompt analysis upon submission of a blueprint or sample part.

Hunter Douglas Cold Forgings cover a multitude of needs. Note wide variation in part geometry. Many complex designs formerly considered impossible to produce by cold forging now respond to new techniques developed at Hunter Douglas.

DESIGNERS:

If you want to know more about Hunter Douglas Cold Forgings write on your company letterhead for this free 40 page book, just off the press!

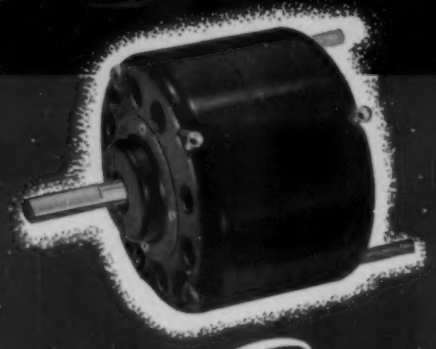
Hunter Douglas Corporation

HUNTER DOUGLAS CORPORATION • DEPT. PE-11 RIVERSIDE, CALIFORNIA TELEPHONE OVerland 3-3030

what's your small motor problem?

☐ Economy?
☐ Dependability?
☐ Quiet operation?

look for the answer in a famous

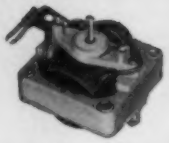


GI Smooth Power MOTOR

Depend on famous GI know-how to produce the right motor to fit your exact needs. Just name your problem. If one of the basic models listed below isn't readily adaptable to your product, GI's engineering department is at your service to help you design a special motor for any specific application. Our complete and modern facilities — backed by over 25 years' experience in solving the motor problems of large and small users throughout the world — are your guarantee of satisfaction. Call or write today for consultation without obligation.

MODEL A
2-pole, shaded pole AC Induction Type

MODEL B
4-pole, 4-coil shaded pole AC Induction Type



MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

MODEL F
2-pole, shaded pole AC Induction Type

NOT SHOWN:

MODEL C — 2-pole, shaded pole AC Induction Type

MODEL O — 2-pole Capacitor Reversible Type, AC only (for 6, 12 or 24 volts)

Write for Complete Motor Catalog

THE GENERAL INDUSTRIES CO.
DEPARTMENT GM • ELYRIA, OHIO

ods of forging, annealing, rolling and descaling and pickling titanium sponge in primary fabrication; and sheet forming, machining, grinding, sawing and joining of titanium in secondary fabrication. E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.

Circle 134, inside back cover

Literature Index–Bulletin 100-D, 24 pp, covers catalogs, bulletins, specification sheets, data sheets and articles from house organ on electrical controls and instruments. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.

Circle 135, inside back cover

Resistors–Engineering guide has data on resistors and special products, including JAN or MIL equivalent, rated wattage, standard tolerances, temperature rise, temperature coefficient, maximum operating temperature, ohmic values available, dimensions and approximate prices. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 136, inside back cover

Flexible Metal Hose–Bulletin 20-E, 4 pp, describes hose of annular and helical construction. Atlantic Metal Hose Co., Inc., 308 Dyckman St., New York 34, N. Y.

Circle 137, inside back cover

Heating Elements – Publication EC-53, 24 pp, describes tubular, strip, water and oil immersion types and domestic water heating elements in both standard and custom-made design. Cutler-Hammer, Inc., 296 N. 12 St., Milwaukee, Wis.

Circle 138, inside back cover

Pressure Gages–Bulletin, 4 pp, contains specifications on pressure and vacuum gages. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y.

Circle 139, inside back cover

Crystal Diodes–Bulletin E 217, 8pp, includes germanium and silicon diodes, glass-encased and plastic-encased. CBS-Hystron, Danvers, Mass.

Circle 140, inside back cover

Needle Rollers–Catalog 61, 12 pp, includes a listing of standard sizes of

(Continued on page 364)

Here's why the IPC "Bond" stays . . . stuck

It's more than a sticking process! IPC in laboratory preparation has discovered a special bonding agent which, under proper molding, causes an affinity between rubber and metal.

IPC bonded case seals and bonded washers can be submitted to the most grueling strain. *The bond between metal and rubber will not break down.*

This absolute adhesion is your protection against packing failure. Your problem can be solved by IPC's "custom bond." Write for details, today.

INTERNATIONAL PACKINGS CORPORATION

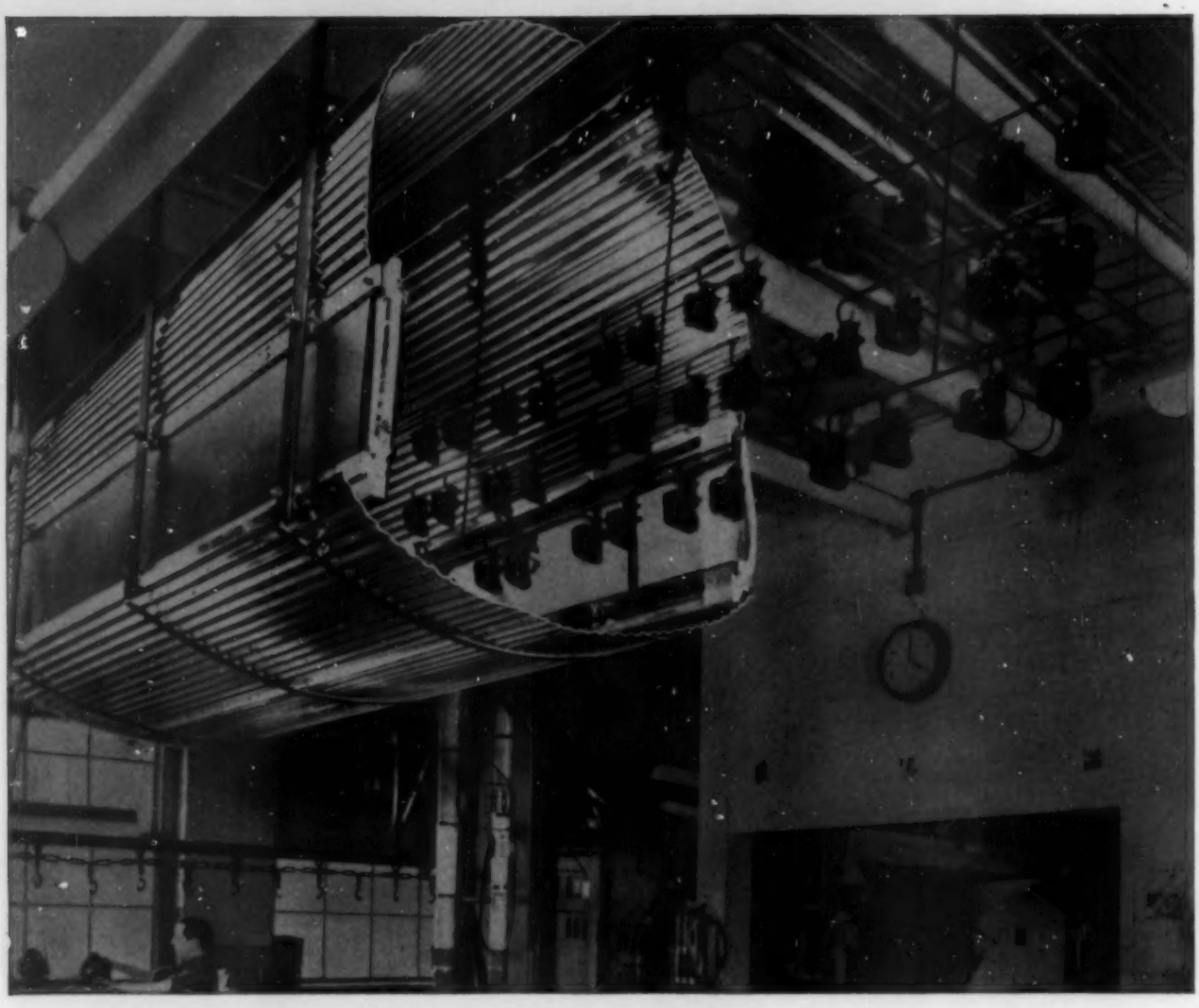
Bristol, New Hampshire

Branch Offices: Chicago, Dallas, Detroit, Kansas City, New York, Philadelphia, San Francisco, St. Louis.

BONDED BY IPC

1. Bonded Washer Seal Double Lip Wiper
2. Bonded Case Seal Double Lip Wiper
3. Bonded Washer Seal Straight Lip
4. Bonded Washer Seal Limited Contact Lip
5. Bonded Washer Seal Straight Lip With Garter Spring
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
7. Bonded Case Seal Straight Lip
8. Bonded Case Seal Limited Contact Lip
9. Bonded Case Seal Straight Lip With Garter Spring
10. Bonded Case Seal Limited Contact Lip With Garter Spring
11. Bonded Case Seal Straight Lip Thin Rind Type
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
13. Rubber Covered Bonded Case Seal Straight Lip
14. Rubber Covered Bonded Case Seal Limited Contact Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

P6



"color blind" far-infrared bakes paints of various colors on metal parts

To bake paint of various colors on different-sized metal parts . . . in large production quantities . . . presented an exacting heat problem for this manufacturer.

Installing four "color blind" Chromalox far-infrared radiant heaters in a reflective overhead oven solved the problem. Total capacity is only 14,400 watts. Longer wave length radiation is "blind" to color differences and therefore heats even white with negligible reflection.

Overhead oven was easy to build; has low initial and operating costs; requires no floor space. Conveyor system readily handles larger units individually or a number of small parts on three tier frames; has operating speed of about 4½ feet per minute.

Results are rapid, uniform baking of paint, regardless of color, on approximately 22,000 units during an eight-hour shift. Fast heat-up time. Minimum maintenance—all-metal radiant heaters are self-cleaning and resist damage.

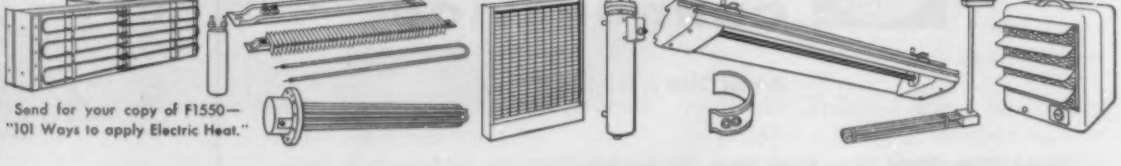
This problem-solution-result approach has enabled us to help many manufacturers produce better, faster, at lower cost.

Always available to you are our research, engineering, design and modern manufacturing facilities. The world's largest factory stock of industrial heaters plus local stocks at strategic points. And a 33-city nationwide sales and application service.

Let us know your problem for controlled heat and we'll go all out to help you find the right answer—electrically. A-4440

EDWIN L. WIEGAND COMPANY
7535 Thomas Boulevard, Pittsburgh 8, Pa.

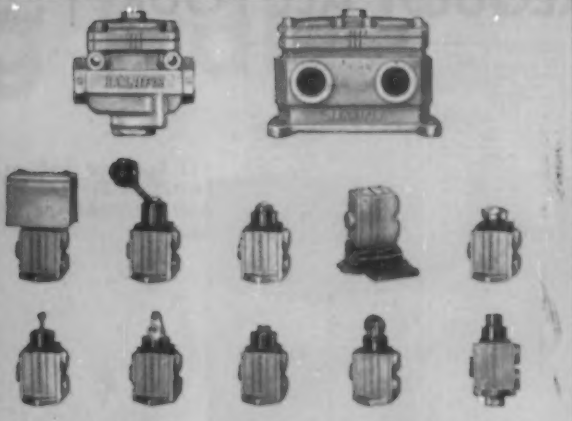
check **CHROMALOX** electric heat for your application



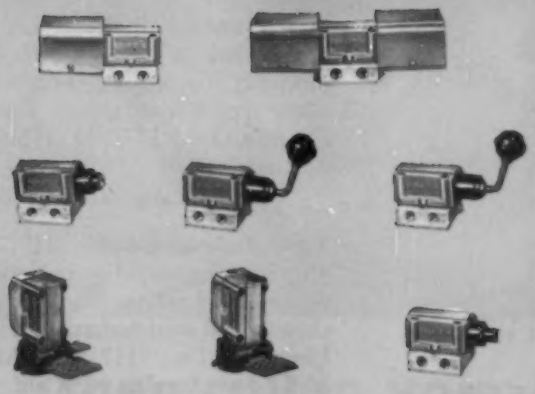
Send for your copy of F1550—"101 Ways to apply Electric Heat."

FOR AIR CYLINDER CONTROL... Manual or Electric

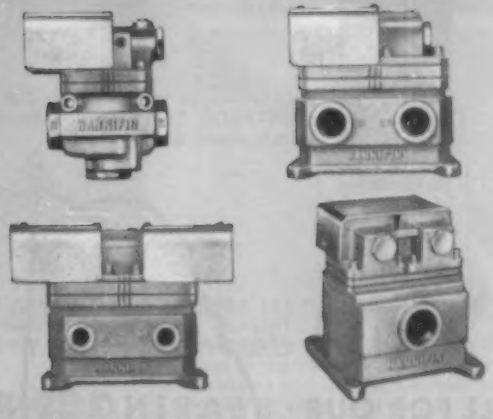
Hannifin Disc Valves. 3-way and 4-way, direct- or pilot-operated. For hand, foot or electric actuation.



Hannifin P-M Master Valves. 2-way, 3-way, 4-way. Remotely controlled from wide choice of Pilot Valves.



Hannifin P-M Direct-Operated 4-Way Valves. Small, compact, inexpensive. For every type operation.



Hannifin P-M Pilot-Master Valves. Solenoid controlled by integral pilot heads. 2-way, 3-way and 4-way.

HANNIFIN has the Air Control Valves for Your Specific Applications

Hannifin has the air control valves you need for use on your production lines or on the products you manufacture, often in a choice of types.

Shown here are typical valves from the extensive and complete Hannifin line. There's a Hannifin valve for every use from the simplest to the most complicated air-operated circuit. Singly or in combination, Hannifin valves provide hand, foot, cam, pressure or solenoid operation . . . in almost every pipe size.

You can simplify your air control valve problems by standardizing on Hannifin. Call in your Hannifin representative, who will discuss your valve requirements. Meanwhile, write for our complete Control Valves catalog.

WRITE FOR BULLETIN

Your copy of the complete Hannifin Control Valves catalog will be sent on request.

Stock Delivery on all types!

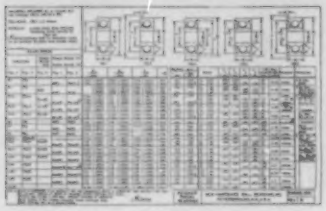
HANNIFIN

Hannifin Corporation, 525 S. Wolf Road, Des Plaines, Ill.

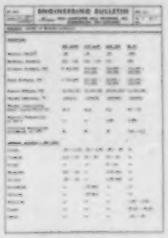
Air and Hydraulic Cylinders • Pneumatic and Hydraulic Presses • Riveters • Air Control Valves

REQUEST ALL FOUR

for up-to-date data on MICRO instrument bearings



(1) For your drafting board or desk, PRINT 1031 HANDY WORK SHEET with complete line of Retainer Radial Bearings.



(2) Answers to specific Questions are provided by more than 20 current N. H. B. B. ENGINEERING BULLETINS.

(3) Concise yet complete, the N. H. B. B. CATALOG 53 is the Handbook of the Instrument Bearing field.

(4) Monthly, the NEW HAMPSHIRE SCENE (friendly house organ) provides humor plus CURRENT ENGINEERING TIPS from N. H. B. B.

CALL FOR OUR BEARING ENGINEERS

- **PACIFIC COAST**
  KERMIT T. SIMONS — 434 North Lake Ave.
  Tel. RYan 1-9051 — **PASADENA 4, CALIFORNIA**
- **MIDWEST**
  JOSEPH W. DANIELS — 49 E. Cedar St.
  Tel. SUperior 7-0984 — **CHICAGO, ILLINOIS**
  CHARLES S. WARD — 646 Hazelwood
  Tel. Trinity 1-4601 — **DETROIT, MICHIGAN**
- **SOUTHWEST**
  J. ROBERT NATOLI — P. O. Box 10203
  Tel. Sterling 2826 — **DALLAS, TEXAS**
- **EAST**
  SIDNEY J. GOODRICH — 61 Cutler Mill Rd.
  Tel. HUnter 2-8633 — **GREAT NECK, NEW YORK**
  CARL F. GRAESSER, JR. — Tel. 424 or 425
  PETERBOROUGH, N. H.

NEW HAMPSHIRE BALL BEARINGS, INC.

Peterborough, N. H.

Phone 424 — 425

needle rollers plus application data which includes capacity and design specifications. Kaydon Engineering Corp., Muskegon, Mich.

Circle 141, inside back cover

A-c Potentiometer—Brochure, 4 pp, describes features, design principle and specifications. Perkin-Elmer Corp., Norwalk, Conn.

Circle 142, inside back cover

Tube Fittings—Charts show variation of load at yield of Type 304 stainless steel tubing when held by tube fittings made by this manufacturer. Crawford Fitting Co., Cleveland 10, Ohio.

Circle 143, inside back cover

Servo Amplifier—Bulletin, 8 pp, describes line of magnetic amplifiers, providing circuit diagrams, curves, other specification data. Feedback Controls, Inc., 1332 N. Henry St., Alexandria, Va.

Circle 144, inside back cover

Tape Resistors—Bulletin HEC-1, 4 pp, gives characteristics and discusses design considerations affecting printed circuitry and miniaturization. Hansen Electronics Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif.

Circle 145, inside back cover

V-Belt Drives—Booklet 2040, 74 pp, contains information on design features, basic drive principles and technical data on sheaves as well as hints for operation of V-belt drives. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.

Circle 146, inside back cover

Wheel Bearings—Bulletin, 54 pp, contains comprehensive information on wheel bearing types, selection, mounting, lubrication, as well as comparative charts on combined radial and thrust capacities. Hartford Steel Bearing Co., Hartford 6, Conn.

Circle 147, inside back cover

Rubber-Phenolics—Brochure CDC-237A, 32 pp, contains 25 concise case histories. General Electric Co., Pittsfield, Mass.

Circle 167, inside back cover

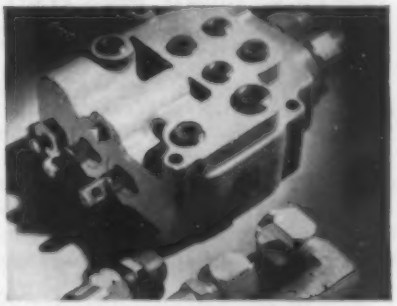
Rotary Gear Pump—Bulletin H2, 8 pp, describes pump for oils, burner service, hydraulic machinery, lube oil cir-

(Continued on page 368)

O-ring leaks?

Heat failure was caused by a combination of compound and design problems. Parker field engineer was called. Leaks were stopped . . . and complaints ended.

Compare actual samples. Ask your Parker representative to check your specifications and design. Let him prove how Parker O-rings seal better, last longer.



What other Parker products interest you? *Triple-lok* flare tube fittings? Ferulok flareless fittings? *Hoze-lok* fittings? Hydraulic directional control valves?

. . . then call in your Parker field engineer for help

Having trouble with O-ring failures? Nibbled, worn, battered, leaking like a sieve? Whether your problem is in the basic design or compound, it's time to call a Parker representative.

Parker field engineers are trained trouble shooters. There is one in your area. From Parker you can get exactly the *right* O-ring and gland design for your *specific* application.

Compare Parker O-rings with any other make. You'll find that Parker O-rings are precision-molded of superior compounds. They have been developed as the result of years of experimentation to provide the proper elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures. Laboratory and service tests make sure that all rated characteristics are held.

Call your Parker representative for assistance. Mail the coupon for *free* technical bulletins about O-rings.

RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 So. Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components

RUBBER PRODUCTS DIV.
Section 513-D
The Parker Appliance Co.
17325 Euclid Ave.
Cleveland 12, Ohio

Please send the following bulletins:

- ☐ Silicone Rubber Bul. 5605 B1
- ☐ Materials for O-rings Bul. 5705 B1
- ☐ O-ring Operation Factors Bul. 5705 B2
- ☐ Thermal Properties Bul. 5705 B4
- ☐ Rotary Seal for High Speed Bul. 5705 B5
- ☐ Aircraft Hydraulic Packings Bul. 5712 B1

Name _____
Company _____
Address _____
City _____ State _____

GRC DIE CAST TINY PARTS HAVE MADE BIG CHANGES IN DESIGNERS' THINKING

Provide big opportunities for new designs, new products, new production economies.

Amazing design flexibility, made possible through Gries' unique die casting techniques, has made significant changes in designers' thinking.

They find that GRC has developed special, exclusive techniques which turn out simple or intricate parts, completely trimmed and ready for use, in *one automatic operation.*

The resulting economies, and the design latitude the Gries' methods provide, open new horizons to designers in both product development and production economies. Frequently, manufacturing operations such as slots, square holes, flats on round surfaces are completely eliminated, and even multiple part assemblies can be produced automatically!

Parts are made to fit size, shape and tolerance specifications *precisely*, and are mass-produced in quantities of 100,000 to many millions. *Smallness* is unlimited: Maximum weight, ½ oz., maximum length, 1¼ inches.

MODERN UP-TO-DATE GRIES PLANT OFFERS COMPLETE FACILITIES

The modern Gries plant in Westchester County, New York, provides large scale production facilities for small precision parts. It offers complete tooling and design equipment, as well as facilities for secondary operations such as tapping, drilling, assembling, reaming and special machining.

Practically all commercial finishes for zinc alloy die castings can be applied. Gries' many years of experience in finishing small die castings provides highest quality finishes at lowest cost.

GRIES OFFERS MANY OTHER PRODUCTS AND SERVICES

Gries can furnish many zinc alloy products directly from stock — including die cast industrial fasteners, and has facilities for the precision molding of tiny plastic parts. If you are interested in any of these other products and services, write direct for specific information.

GRIES OFFERS FACT-FILLED INFORMATIVE DIE CASTING BULLETIN

Gries offers a factual bulletin containing charts of approximate dimensional and weight limits, comparisons of the GRC die casting method with other methods, composition and properties of zinc alloys for die castings as well as illustrations of many typical small parts and design engineers' guide for reference in designing products that use small parts.

WRITE, WIRE OR PHONE TODAY

for your copy of the Gries Die Casting Bulletin. Find out how Gries can help you solve your parts problems — economically and efficiently. Send prints for quotations.

GRIES STAFF OF ENGINEERS AVAILABLE FOR CONSULTATION

GRC maintains a staff of experienced engineers to aid manufacturers on all phases of design production. They will design production dies that best utilize the special machines and processes that have been developed by Gries over a period of 40 years. Gries engineers are available for consultation at any time.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

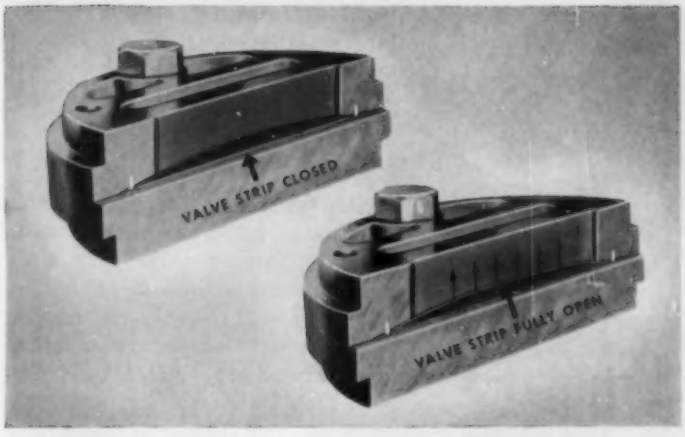
GRIES

GRIES REPRODUCER CORP.

159 Beechwood Ave., New Rochelle, N. Y. NEw Rochelle 3-8600

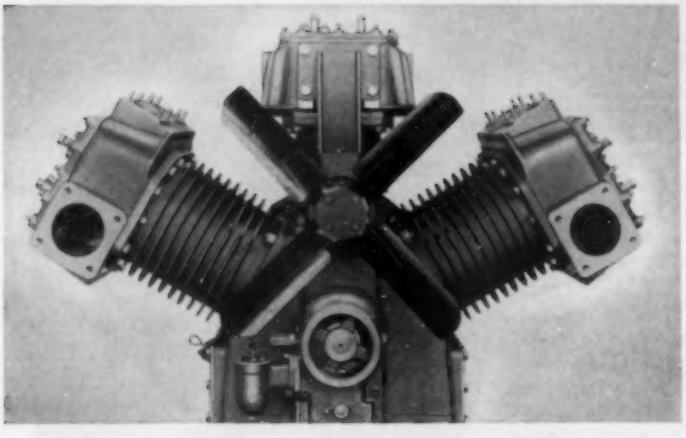
WHAT'S YOUR C.Q.*?

*COMPRESSOR QUOTIENT



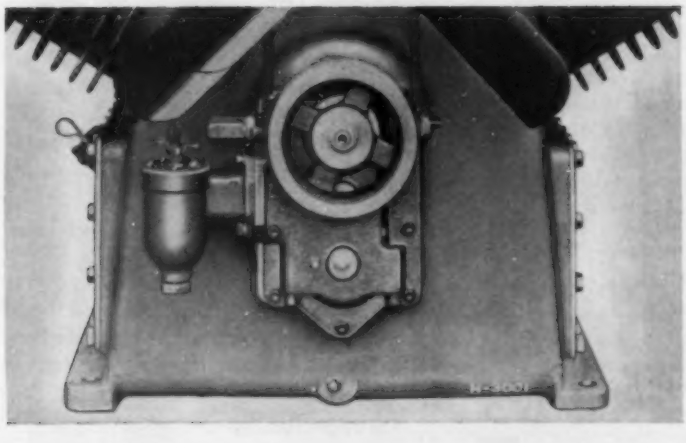
What's the lightest-acting air compressor valve made?

No doubt about this one — it's Worthington's exclusive Feather* Valve. Responsive as a feather to air flow, it can open, release air and close in one-hundredth of a second—with no back-leaking and efficiency losses. You can get more information about the Feather Valve by writing for Bulletin L-675 S12.



How can you get effective air cooling of air compressors?

Fan-cooling of isolated cylinders is the answer. In Worthington Radial and Balanced Angle air compressors, cooling air flows completely around the isolated cylinders. And the high-capacity fan blows air directly over upper parts of cylinders and cylinder heads — where heat is greatest. Our Bulletin H-630-B1 tells you more about Worthington Radial air-cooled air compressors.



What's the <u>modern</u> way to lubricate an air compressor?

The right answer is force-feed lubrication—with continuous full-flow oil filtration. And that's exactly what you get in Worthington Radial Air Compressors (and *only* Worthington, by the way). Result: less bearing wear, less oil pumping, longer cylinder life and lower lubricating oil cost. One twist of the handle cleans the Cuno filter without stopping flow. Read Bulletin H-630-B1 for more facts. PC.5.3

Reg. U.S. Pat. Off.

Write today for bulletins to Worthington Corporation,
Section PC.5.3, Harrison, N.J.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON <u>YOUR</u> EQUIPMENT

Air Compressors • Pumps • Multi-V-Drives • Allspeed Drives

Jet airpower is the backbone of America's defense, and jet engines depend upon scientifically exact turbine vanes, turbine blades and supercharger buckets for power and performance.

To mass-manufacture these vital precision parts, Austenal applies the ancient "lost wax" method of investment casting, greatly improved and now called Microcast—a technique so precise and so accurate that Austenal turbine buckets and vanes eliminate costly machining and require only a minimum of finishing.

The Microcast process was developed by Austenal, and its use in the manufacture of vital jet components is only one of many applications. In every field of industry, Microcast is proving that complex, intricate metallic parts can be made better and more economically by investment casting.

Let Austenal show you how Microcast can help brighten your production picture.

Write today for Austenal's informative booklet, "Design with Microcast in Mind".

austenal®

MICROCAST PRECISION CASTINGS PROCESS

LABORATORIES, INC.

microcast division

224 EAST 39th STREET · NEW YORK 16, N. Y.

culation, chemicals, marine service and general transfer, in the range of 32 to 250,000 SSU, 1 to 350 gpm, 300 psi for continuous duty, 500 psi for intermittent service. Sier-Bath Gear & Pump Co., Inc., 9252 Hudson Blvd., N. Bergen, N. J.

Circle 149, inside back cover

Surface Chromium Alloying—Bulletin, 4 pp, describes surface alloying technique for increasing the heat, wear and corrosion resistance of ferrous metals by diffusing chromium into the surface at high temperatures. Chromalloy Corp., 109 W. 64 St., New York 23, N. Y.

Circle 150, inside back cover

Three-Dimensional Cams—Folder, 4 pp, describes evolution of three-dimensional cams from theory to working product. Parker Stamp Works, Inc., 650 Franklin Ave., Hartford, Conn.

Circle 151, inside back cover

Electric Clutch—Folder, 4 pp, describes electrically actuated disconnect couplings with static torque ratings ranging from 52 to 788 lb-ft. Warner Electric Brake & Clutch Co., Beloit, Wis.

Circle 152, inside back cover

Springs—Data sheets, 10 pp, include subjects such as spring index, coil diameter variation, modulus and physical properties of spring materials, tolerances and a comparison of cost and physical characteristics of spring materials. Hunter Spring Co., Lansdale, Pa.

Circle 153, inside back cover

Capacitors—Bulletin XC-201-4, 6 pp, gives technical information on high temperature plastic film dielectric hermetically sealed tubular capacitors. Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

Circle 154, inside back cover

Vibration Mountings – Catalog FP 55, 4 pp, gives load capacities and frequencies, illustrations of typical installations. T. R. Finn Co., Inc., 200 Central Ave., Hawthorne, N. J.

Circle 155, inside back cover

Electrical Tachometers—Catalog D9A, 19 pp, gives details on bearing-less

Continued on page 372

POLYETHYLENE SKIRT is flexible . . . seals against mounting surface and wire lead, providing a complete dust and moisture seal.
SNAP-IN MOUNTING PRONGS are shaped for easy push-in entry into mounting hole and snap outward to lock socket securely in place. Prongs are firmly anchored in plastic skirt.
AUTOMATIC GROUNDING of socket is provided by positive contact between mounting prongs and mounting surface.
available with springs and washers preassembled

NEW

plastic lamp socket

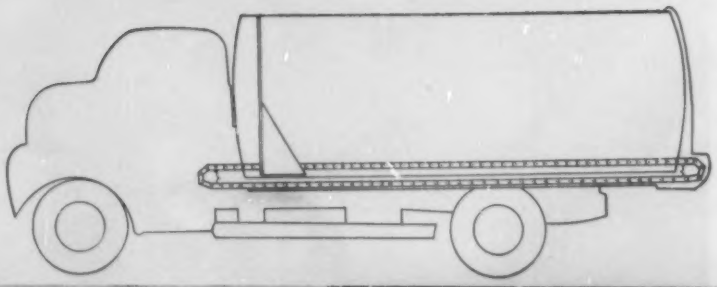
SEALS OUT MOISTURE and DUST

United-Carr's in-plant plastic molding facilities permit complete control of quality and performance in the manufacture of devices in which metal and plastics are combined. This enables United-Carr to offer truly comprehensive and reliable service on custom-designed fasteners and self-fastening electrical devices. For further information . . . sizes, prices, etc., contact your nearest United-Carr representative or write us direct.

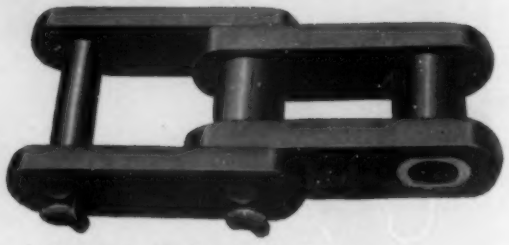
UNITED-CARR
FASTENER CORPORATION
31 Ames Street, Cambridge 42, Massachusetts

MAKERS OF DOT FASTENERS

Pak-Mor refuse collection units are sanitary, large-capacity models. Diagram shows how Jeffrey chain moves packer plate—applying power from truck power takeoff. Below is 20 cu. yd. Pak-Mor unit mounted on a Ford COE chassis.



JEFFREY chain packs more power



Jeffrey Steel Knuckle Chain
Straight Side Bar Type

Pak-Mor Manufacturing Company, San Antonio, Texas, had a special problem: They wanted a powerful, long-lasting chain to drive the packer plate in their refuse collection units.

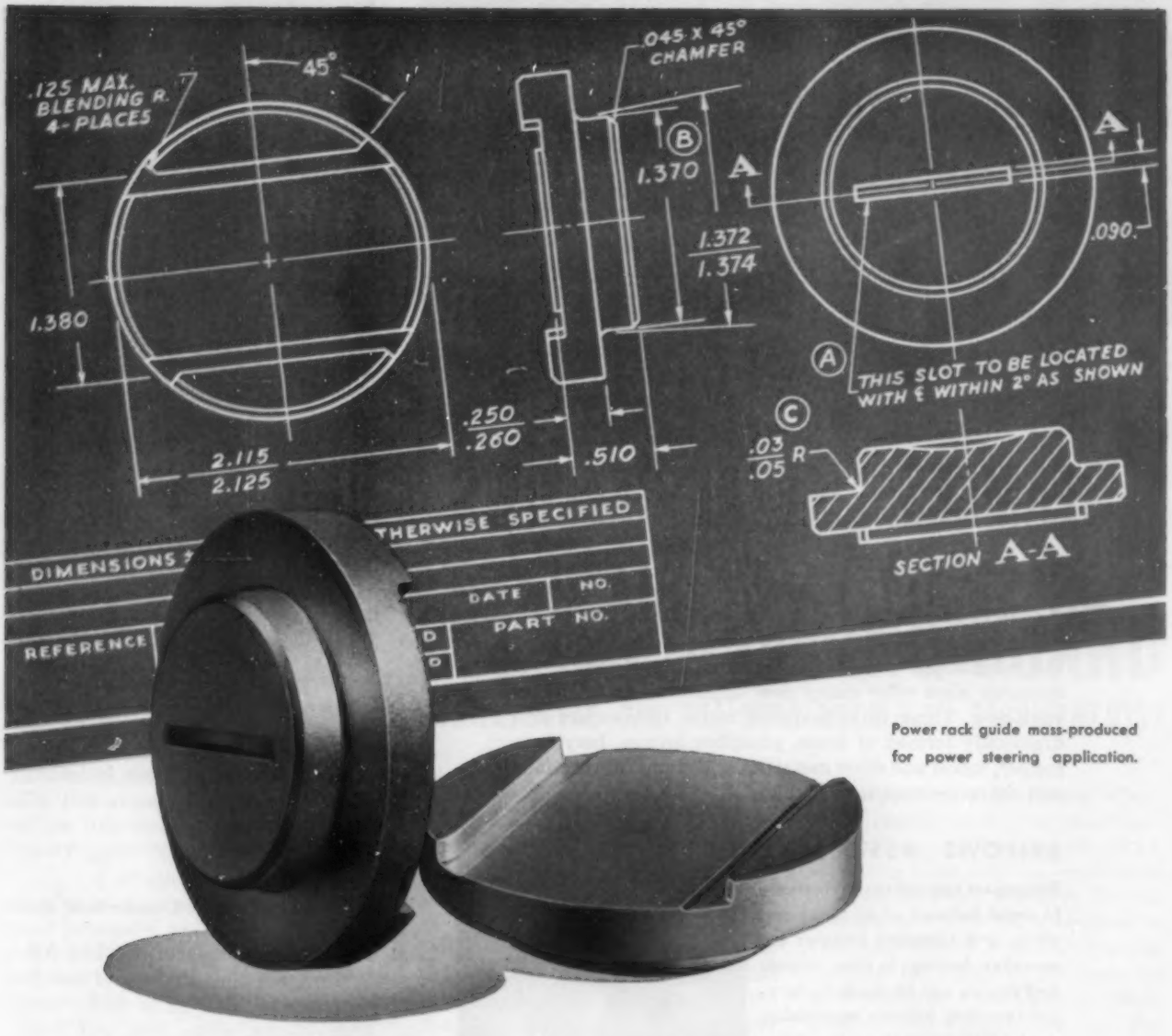
Jeffrey engineers designed a steel knuckle chain for the job. It transmits the truck's own power, through a power takeoff and gear reducer, to compress rubbish and garbage in the truck and then eject it at the disposal site.

Pak-Mor and Jeffrey have worked as a team for more than ten years now. High quality chain helps Pak-Mor units make longer collection trips, saving money for cities and towns . . . and in turn the people of the community.

Jeffrey design and production experience are ready to work for you, too, on any of your power transmission or conveying problems. Send your problem to our Merchandise Sales Division today.

THE JEFFREY MANUFACTURING CO.
ESTABLISHED 1877
Columbus 16, Ohio
sales offices and distributors in principal cities
PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED
. . .IT'S A JOB FOR JEFFREY!



Power rack guide mass-produced for power steering application.

MORAINE METAL POWDER PROCESS MAKES COMPLEX PARTS - AT A SAVINGS

If made by conventional casting and machining methods, this part, which serves many of us every day, would cost more. Made by the Moraine metal powder process, however, the part is mass-produced quickly and economically—to precision standards.

Moraine makes many different parts of complex design from metal powder . . . parts with a quality and uniformity that make them highly desirable for a multitude of applications.

Many industries are using Moraine's experience in powder metallurgy to reduce the cost and improve the performance of many and varied products. Possibly, Moraine may be of service to you, too.

moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

METAL POWDER PARTS

Design News from Bridgeport Thermostat

SEAMLESS METAL BELLOWS AS SMALL AS ¼" DIAMETER

For miniaturization, Bridgeport bellows in ¼" and 5/16" diameter sizes offer many new opportunities to design engineers. These tiny, seamless metal bellows are hydraulically formed of brass, phosphor bronze, beryllium copper, monel and other metals. A wide range of reactions and characteristics is available.

BELLOWS ASSEMBLIES

Bridgeport specializes exclusively in metal bellows of all types and sizes, and complete bellows assemblies. Savings in time, trouble and money can be made by buying complete bellows assemblies . . . let Bridgeport show you how.

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • MILFORD, CONN.

Send me the Bridgeport bellows data checked below: (Dept. VP-1400)

☐ Full details on new, small-diameter bellows

☐ Bellows Engineering Bulletin #125 (28 pages)

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

tachometer generators, as well as on a-c and d-c voltage–responsive and frequency-responsive tachometer systems. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

Circle 156, inside back cover

Electrical Relays—Catalog R-55, 12 pp, describes relays designed for precision aircraft electronic equipment conforming to highest standards of inspection with excellent military ratings in quality control. Iron Fireman Mfg. Co., 2838 S.E. Ninth Ave., Portland 2, Ore.

Circle 157, inside back cover

Electronic Relay—Publication 585, 2 pp, provides design and application information, circuit description and complete dimensional and pricing data. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle 158, inside back cover

Capacitors—Catalog sheet, 2 pp, shows standard units which come in bathtub and rectangular can types in 200, 400 and 600 v ratings, from 0.05 to 25 mfd. Corson Electric Mfg. Corp., 540-39 St., Union City, N. J.

Circle 159, inside back cover

Pneumatic Equipment—Booklet ML-3, 8 pp, contains illustrations and descriptions of drill press feeds, vises, hydro-checks, rotary feed and index tables, self-contained drilling units, valves and cylinders. Bellows Co., 222 W. Market St., Akron, Ohio.

Circle 160, inside back cover

Threaded Bushings—Catalog, Section E, 44 pp, describes fastening that combines functions of a nut and a washer, for use in either wood or metal. Various types are pictured and detailed specifications given. United-Carr Fastener Corp., 31 Ames St., Cambridge 42, Mass.

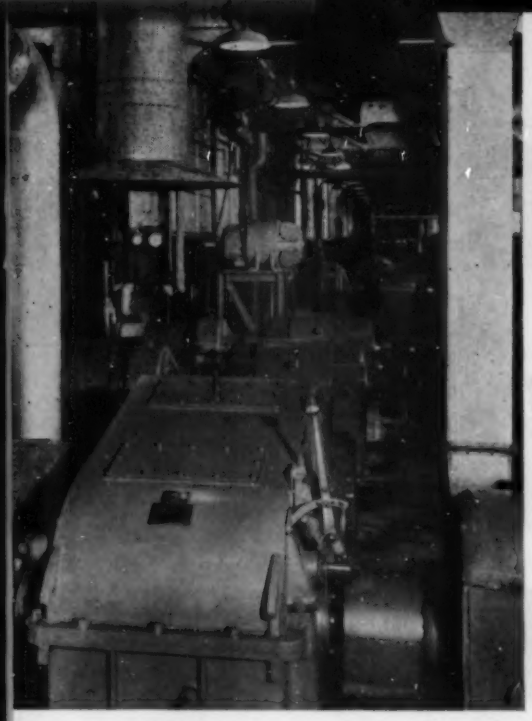
Circle 161, inside back cover

Porcelain and Stoneware—Bulletin CHE-55, 15 pp, describes pipe, fittings, valves and pumps, other equipment. General Ceramics Corp., Keasbey, N. J.

Circle 162, inside back cover

Hydraulic and Air Components—Catalog 555, 36 pp, describes specifi-

(Continued on page 376)



FORMERLY a prominent mill lost time changing gears for processing heavy grades of Kraft board because of additional drag and increased load which overtaxed the motor. Western Gear solved the problem by installing a two-speed drive with optional ratios of 6.94:1 and 14.04:1 with 400 HP input in either ratio. Gear changes now are made by merely shifting a lever. Man hours were saved and motor overload was prevented.

WESTERN GEAR diesel-engine-driven speed increasers, among the largest ever constructed for U.S. pipeline service, are exclusively used on Mid-Valley's 1,000-mile pipeline. Daily pumping capacity of this huge pipeline has been increased recently by the addition of two new 1800 HP units.

RIGHT ANGLE PUMP DRIVES designed and manufactured by Western Gear shown here installed in the San Diego municipal water treatment plant. Western Gear manufactures a complete line of drives for high horsepower or high speed right angle application.

OUT OF THE CATALOG OR OFF THE DRAWING BOARD

WESTERN GEAR CAN FILL YOUR MACHINERY REQUIREMENTS!

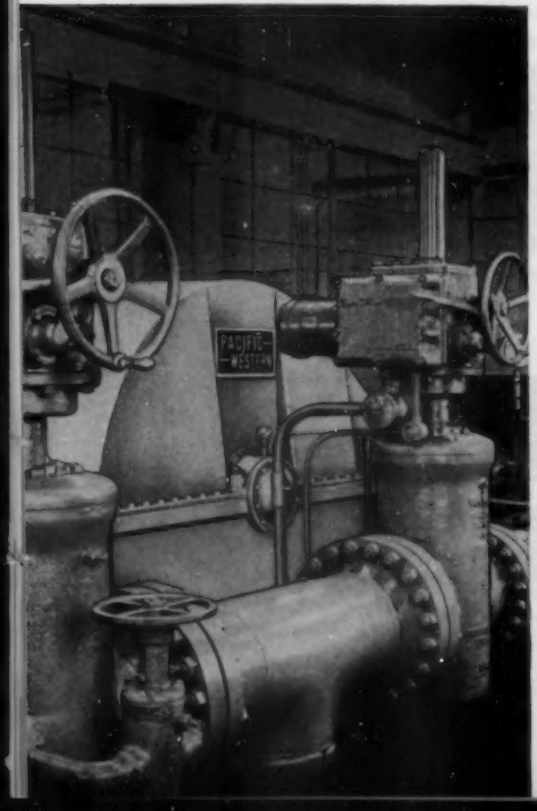
Whatever the application, call on Western Gear engineers for assistance. Their recommendations are based on experience accumulated since 1888 in the design, testing and manufacture of virtually any type of mechanical power transmission equipment. This extensive background in special machinery design and construction ranges from fractional horsepower motors to mammoth marine cable laying devices, from pulp mill machinery to tiny guided missile components and from printing presses to peach pitters.

Western Gear skill has contributed to virtually every industry. The experience and knowledge obtained is your assurance of reliability and outstanding performance. For help on your problem, write General Offices, Western Gear Corporation, P.O. Box 182, Lynwood, California.

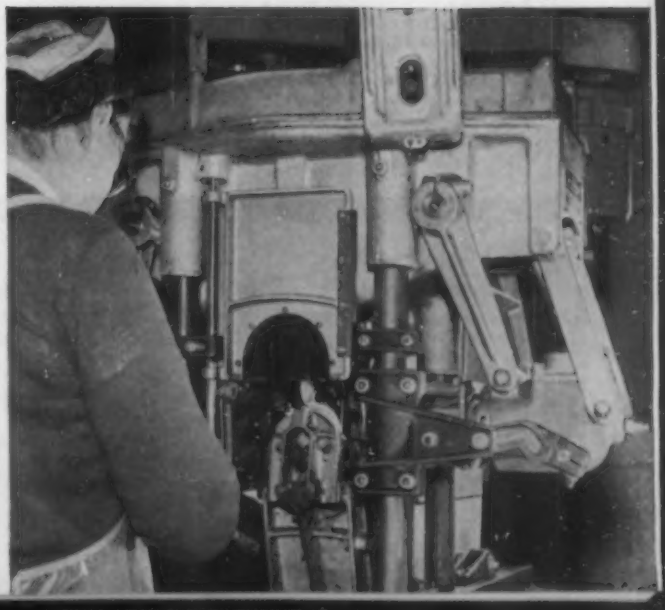
"The difference is reliability" • Since 1888

WESTERN GEAR *Corporation*
ENGINEERS AND MANUFACTURERS

5586



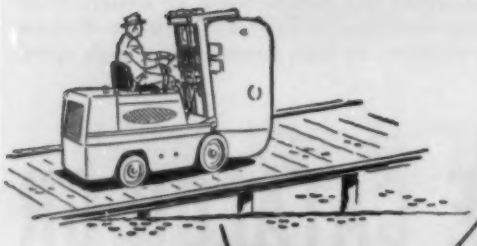
PEACH PITTER which halves and pits cling peaches mechanically, constructed by Western Gear for the Filper Corporation to be used by the Filice & Perrelli Canning Company, a leader in the California fruit canning industry. The Filper process is said to improve both the quality and the yield while it also reduces hand labor.



PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

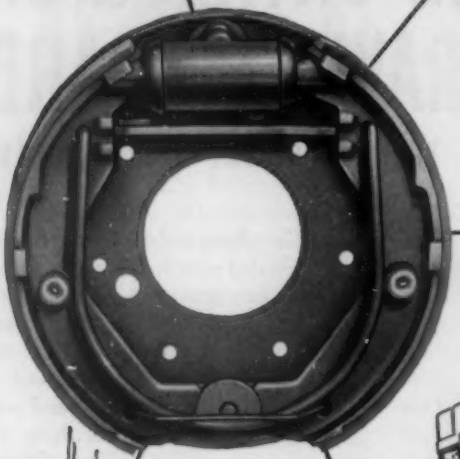
IF IT MOVES

WE CAN STOP IT!



TDA BRAKES

...for every industrial or automotive application where braking is required!



FSH...Floating Shoe Hydraulic Brake
Designed for close control with heavy loads

The FSH Brake presents some remarkable new advantages to manufacturers who need a better, longer lasting Hydraulic Brake. The features of the FSH were developed after years of field work and laboratory study. These advantages can be a road to new economy and better control for *your* equipment.

FSH Brake shoes operate with a floating action. This eliminates the danger of liner loads concentrating at one point . . . permits the shoe to follow the drum. The result of this even load distribution is a highly dependable, controllable brake—*in either direction* of travel. This is especially important when stacking heavy loads at high levels and maneuvering at close quarters.

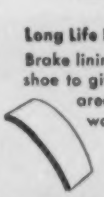
For Additional Information . . . contact the Timken Brake Division. Complete details on the FSH Brake are available. And, a staff of experienced engineers can assist you with any brake problem you encounter.

Mechanical Parking Brake Hook-up

A separate parking brake is no longer necessary with FSH. If specified, the FSH Brake can be furnished with a mechanical parking brake linkage that functions independently of the hydraulic system.

Long Life Lining

Brake lining is bonded to the shoe to give maximum lining area with no lining waste.



Positive Automatic Adjustment

One application of the foot pedal sets the automatic adjustment. No further adjustment of the brake is required during the full life of the brake lining.

Positive Contact Drum Seal

For applications where a sealed brake is required, the FSH is designed to incorporate a seal between the brake backing plate and brake drum.

TIMKEN Detroit BRAKES

TIMKEN DETROIT BRAKE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
WARREN, OHIO

Accepted SAE Standard

TRADE MARK REGISTERED

HOW TO CUT WEIGHT AND ADD Strength

More and more industries look for ways to decrease weight without the loss of strength. In many cases, Spaulding products have shown them the way. Spauldite (laminated thermosetting plastic) and Spaulding vulcanized fibre are among the Spaulding products which provide extremely light weight in combination with structural strength, resistance to wear and other desirable characteristics.

Spaulding products for industry weigh only half as much as aluminum — show amazing performance characteristics in meeting tough industrial applications. Spaulding products can be provided in types and grades to give you the mechanical, electrical and chemical characteristics needed for your specific application. With their use, you may be able to solve a difficult design problem — reduce weight — improve product performance or lower production costs.

For full information, write or telephone your nearest Spaulding Branch Office.

Spaulding

WE MAKE AND FABRICATE

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.
ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.
SPAULDITE: (Laminated Thermosetting Plastic) in sheets, rods, tubes and fabricated parts.
SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.
SPAULDING FIBRE BOARD: In sheets and fabricated parts.
SPAULDING T BOARD: A superior Transformer Board in sheets and fabricated parts.
MATERIALS HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.
SPAULDING FABRICATING FACILITIES: Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation.

FIBRE COMPANY, INC.
TONAWANDA, N. Y.

SPAULDING BRANCH SALES OFFICES

BALTIMORE 18, MD.
BOSTON 16, MASS.
BRIDGEPORT 5, CONN.
CHICAGO 25, ILL.
CHICAGO 38, ILL.
CLEVELAND 14, OHIO
CLEVELAND 16, OHIO (Rocky River)
DAYTON 2, OHIO
DETROIT 1, MICH.
FORT WAYNE 6, IND.
LANSING 10, MICH.
LONG ISLAND, N. Y. (Woodhaven 21)
MILWAUKEE 8, WIS.
NEW YORK 55, N. Y.
NEWARK, N. J. (Westfield, N. J.)
PHILADELPHIA, PA. (Camden 3, N. J.)
ST. LOUIS 5, MO.
TONAWANDA, N. Y.
LOS ANGELES 15, CALIF. C. D. LaMoree
BERKELEY 10, CALIF. C. D. LaMoree
TORONTO 18, ONT. A. A. Andersen & Co.

new precision in extended range vibration testing:

CALIDYNE'S "HI-FI" SHAKER SYSTEM

Precisely controlled vibration testing — over the *5 to 5000* cps frequency range at *full* rated output — is now a reality with Calidyne's new Series 8000 Shaker System. The Shaker itself incorporates an extremely rigid armature structure, designed to eliminate all secondary structural resonance in the operating frequency range. Actual frequency response values obtained by test are ±1 db, 7 to 2000 cps; ±3½ db, 5 to 5000 cps (bare table). Full ½" peak-to-peak displacement or 600 pounds force output is maintained at all frequencies, *without* power factor correction or use of changeable impedance matching taps.

A control console incorporates all operating controls, and associated monitoring and cycling equipment. Switch selected inputs consist of single frequency, sweep cycling or complex waveform signals. Special features include a dual beam 'scope for comparing input and Shaker table acceleration signals, and five adjustable circuits to compensate for decrease in transfer function (g output/volts input) as frequency increases.

Complete Engineering Data and Specifications on Request

THE CALIDYNE COMPANY

120 CROSS STREET, WINCHESTER, MASSACHUSETTS

SALES REPRESENTATIVES:

WALTHAM, MASS. Robert A. Waters, Inc. Waltham 5-6900
NEW HAVEN, CONN. Robert A. Waters, Inc. Fulton 7-6760
NEW YORK CITY AREA G. C. Engel & Associates Rector 2-0091
RIDGEWOOD, NEW JERSEY G. C. Engel & Associates Gilbert 4-0878
PHILADELPHIA, PA. G. C. Engel Chestnut Hill 8-0892
NORTHERN NEW YORK Technical Instruments, Inc. Waltham, Mass. Waltham 5-8445
CLEVELAND, OHIO M. P. Odell Co. Prospect 1-6171
DAYTON, OHIO M. P. Odell Co. Oregon 4441
DETROIT, MICHIGAN M. P. Odell Co. Superior 8-5114
WASHINGTON, D. C. F. R. Jodon, Inc. Hobart 2-4300
SOUTHEAST W. A. Brown & Assoc. Alexandria, Va. Overlook 3-6100
CHICAGO, ILLINOIS Hugh Marsland & Co. Ambassador 2-1555
INDIANAPOLIS, INDIANA Hugh Marsland & Co. Glendale 3803
MINNEAPOLIS, MINN. Hugh Marsland & Co. Colfax 7949
DALLAS, TEXAS John A. Green Co. Fleetwood 7-7385
HOLLYWOOD, CALIFORNIA G. B. Miller Co. Hollywood 2-1195
SAN FRANCISCO, CALIF. G. B. Miller Co. Lytell 3-3438
ALBUQUERQUE, NEW MEXICO G. B. Miller Co. Albuquerque 5-8606
SEATTLE, WASH. G. B. Miller Co. Lander 3320
CANADA Measurement Engineering Ltd. Arnprior, Ont., Phone 400 Toronto, Ont., Mayfair 8860
EXPORT Rocke International Corp. 13 East 40th St., N. Y. 16, N. Y. Murray Hill 9-0200

cations and applications of pumps, cylinders, jacks, braces and other units. Star Jack Co., Inc., 420 Lexington Ave., New York 17, N. Y.

Circle 163, inside back cover

Power Transmissions—Bulletin 1003, 8 pp, describes rotary and linear actuators, ball screw and spline mechanisms, gear assemblies, hydraulic components. Vard, Inc., 2981 E. Colorado St., Pasadena 8, Calif.

Circle 164, inside back cover

Electronic Controls—Bulletin EC-1, 16 pp, contains non-technical, simplified information on the installation, performance and maintenance of stepless speed control of equipment. Eaton Mfg. Co., Kenosha, Wis.

Circle 165, inside back cover

Investment Casting—Booklet, 11 pp, tells in pictures and text steps involved in investment casting. Includes recent table of properties. Austenal Laboratories, Inc., 224 E. 39 St., New York.

Circle 166, inside back cover

Flexible Metal Hose—Catalog U-333, 20 pp, contains application data on metal hose products made in bronze, carbon steel, Monel, nickel or stainless steel. Universal Metal Hose Co., 2133 S. Kedzie Ave., Chicago 23, Ill.

Circle 167, inside back cover

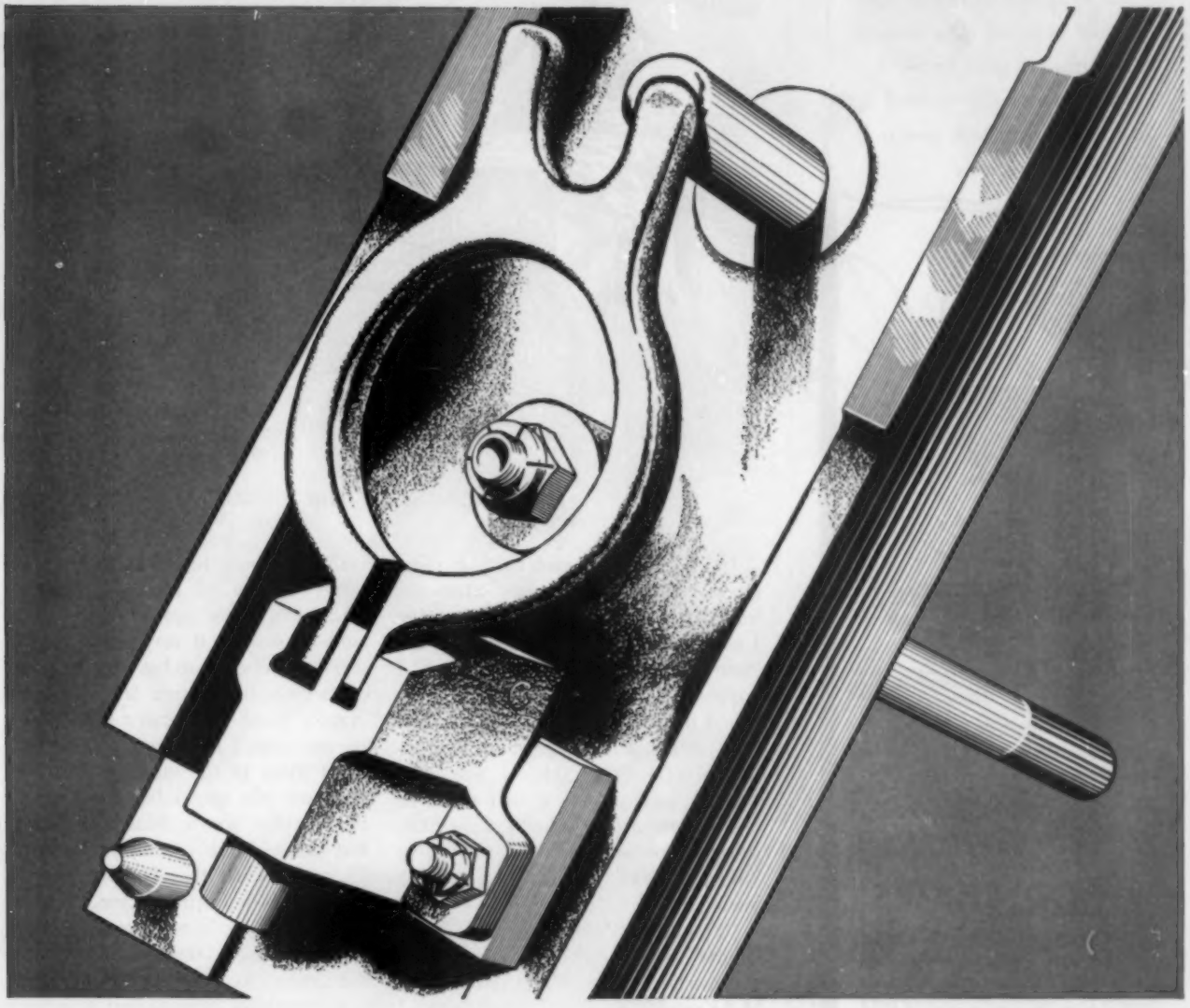
Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Ceramic Capacitors—Catalog CD-102, 22 pp, application data, capacity-per-size designations, specifications and curves for a complete line of ceramic capacitors. Solar Mfg. Corp., E. 46 St. and Seville Ave., Los Angeles, Calif.

Standard Screw Gage—This sheet metal gage will calibrate immediately all sizes of both machine and wood screws from No. 0 through 14. It also has a calibrated scale by 32nds for calibrating all kinds and makes of round stock. Sixty-fourths can be estimated. All standard wood and machine screw sizes can be checked. Dayton Rogers Mfg. Co., 2824 Thirteenth Ave., S., Minneapolis 7, Minn.

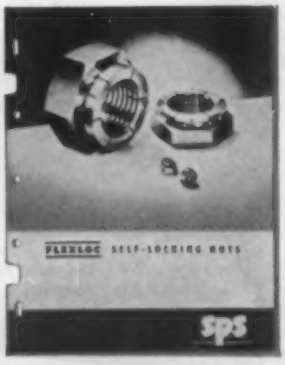
FLEXLOC AT WORK



MORE AND MORE FLEXLOC LOCKNUTS are being used on assemblies where dependable locking is essential to the operating efficiency of the equipment. This stationary spindle is a good example of the difficult jobs FLEXLOC locknuts are doing throughout industry.

FLEXLOCS were put on this unit after a number of other locknuts had failed to keep the spindles tight. Even the high humidity, extreme vibration, and presence of lint and grease have not loosened the FLEXLOCS.

FLEXLOC Self-Locking Nuts—one piece, all metal—are available in a full range of sizes in any quantity. Standard FLEXLOCS are stocked by leading industrial distributors everywhere. Write for Bulletin 866 and samples. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.



DO YOU KNOW? Standard FLEXLOCS smooth off rough bolt threads. The locking threads on all-metal FLEXLOCS are not chewed up when used on rough bolts.

Standard FLEXLOCS lock securely on bolts varying in diameter tolerances. The all-metal, resilient locking sections of the nut accommodate themselves to the diameter tolerances.

Standard FLEXLOCS are one piece, all metal. They are not affected by temperatures to 550°F. Nuts lacking these features have a more restricted temperature range.

Standard FLEXLOCS lock securely—stopped or seated—when 1½ threads of a standard bolt are past the top of the nut.

Standard FLEXLOCS are not affected by moisture, oil, dirt or grit. They lock efficiently under all conditions, regardless of the vibration encountered.

FLEXLOC®
LOCKNUT DIVISION
sps
JENKINTOWN PENNSYLVANIA

• A good chair is like a good wife...if you choose with care, it will look after your comfort and aid you in your work for a long time to come

Cramer CHAIRS ARE

GOOD CHAIRS

Scientifically planned to aid YOU in your work . . . designed to support you comfortably whether you're chewing your pencil or bent over hard at work . . . engineered from the quality materials YOU would recommend, with independently adjustable seat, back and footring to conform to your physique . . . and with removable, replaceable covers in a wide range of fabrics and colors to match YOUR decorating plan.

Pictured, Cramer Hi-Model 4D-22T with forward-tilt seat; others available. All are low-gravity balanced for safe use on casters if desired.

LIKE MORE INFORMATION?

Cramer Posture Chair Co., Inc., Dept. E
1205 Charlotte, Kansas City 6, Mo.
Please send me complete facts on the Cramer Hi-Model chairs designed for working architects and engineers.

Name _____

Firm _____

Address _____

Ad Libbing by the Editor

It has often ben said that we must go far afield to find out what our neighbor is doing. Sitting in London I was reading the Paris edition of the New York Herald Tribune when I happened across a little poem published in that paper. The little poem was published with permission from the Kansas City Star. I was very much intrigued with it so I wrote to the editors of the Kansas City Star, called their attention to the poem "Steve Brodie" and received the following reply:

"You are welcome to reprint "Steve Brodie" in *Product Engineering* with the usual credit to Vaun Arnold and the Kansas City Star." That credit I gladly give, so here is the poem.

Steve Brodie

Lo, how the mediocre waxes great
By showmanship; the clinker is a star
Of brilliance, and the peanut will inflate
Amazingly, through the spectacular.
One ounce of talent with a pound of brag
Outstrips a ton of virtue standing mute;
The silent saint is lost, the scallawag
By blatancy inveigles the salute.
The heard, the seen, the antics of a midge
Incredible will dwarf the finest plan
Of engineers. Who built the Brooklyn bridge?
Who cares! Steve Brodie was the greater man.

Vaun Arnold

Once upon a time I owned a book called Theory of Heat by Preston. Thirty-five years ago I studied that book. I studied it very intensively. I still remember snatches of the proof of Wien's distribution law and Bolzmann's proof of Stefan's law. But I am sure that I could not present that proof today to the satisfaction of any professor who might be giving me an examination for a Master's degree. But there is one section of Preston's Theory of Heat that I will never forget. It was his introduction. This introduction was almost entirely nonscientific and nontechnical as far as the subject matter of Theory of Heat was concerned. Preston had a wonderful philosophy which he expounded in that introduction. And I assume that Preston had had a very tough time of it in trying to get recognition. I say this because in the closing paragraph of that introduction he made a statement something like this:

"Charlatans flourish while the true spirit of science is ground into the dust. But truth must and will always prevail."

I recalled those lines when I read Vaun Arnold's poem which so strikingly brings out the fact that insofar as society is concerned Steve Brodie who was stupid enough to jump off the Brooklyn Bridge was greater than Roebling, the engineer who had designed it.

This reminds me of an incident that happened at a Lehigh alumni dinner. Tom Girdler, Chairman of the Board of Republic Steel was the Master of

(Continued on page 382)

WE'D ENJOY

Serving You

TOO!

DIVISIONS OF
ASSOCIATED
SPRING
CORPORATION

COAST TO COAST

WALLACE BARNES COMPANY
BRISTOL, CONNECTICUT

THE WILLIAM D. GIBSON COMPANY
1800 CLYBOURN AVE.
CHICAGO 14,

RAYMOND Manufacturing COMPANY
CORRY, PENNSYLVANIA

BARNES-GIBSON-RAYMOND
40300 PLYMOUTH RD.
PLYMOUTH, MICH.

B·G·R COOK PLANT
ANN ARBOR
MICHIGAN

SEABOARD Coil Spring Div.
15001 S. BROADWAY
GARDENA, CALIF.

OHIO DIVISION
1825 EAST FIRST ST.
DAYTON, OHIO

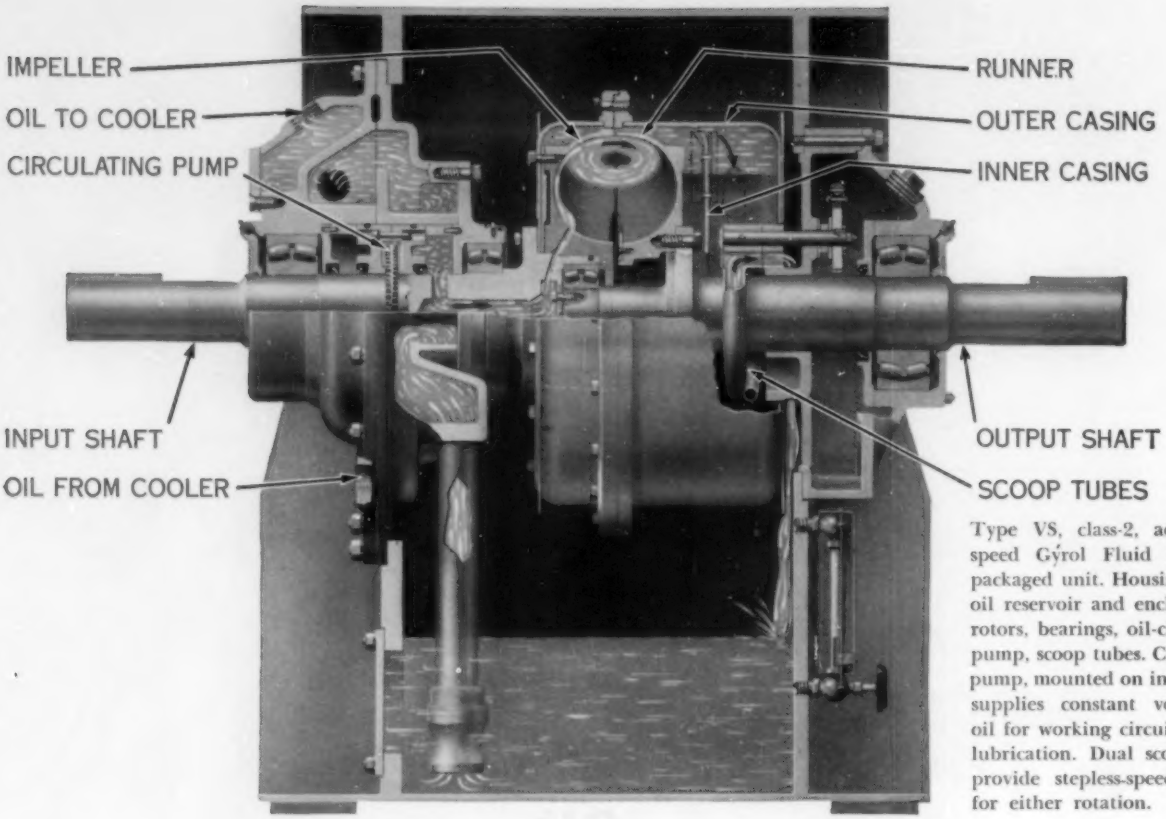
WALLACE BARNES COMPANY
STATE FAIR BLVD.
SYRACUSE 9 (Solvay), N.Y.

MILWAUKEE DIVISION
341 E. ERIE ST.
MILWAUKEE, WIS.

DUNBAR BROTHERS COMPANY
BRISTOL, CONN.

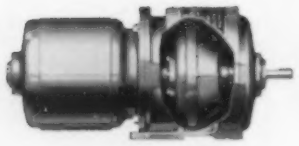
F. N. MANROSS AND SONS CO.
BRISTOL
CONNECTICUT

THE WALLACE BARNES CO., LTD.
HAMILTON
CANADA

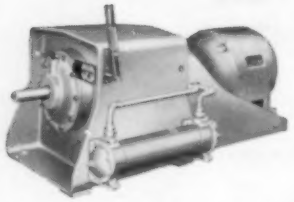


Type VS, class-2, adjustable-speed Gýrol Fluid Drive — a packaged unit. Housing acts as oil reservoir and enclosure for rotors, bearings, oil-circulating pump, scoop tubes. Circulating pump, mounted on input shaft, supplies constant volume of oil for working circuit and for lubrication. Dual scoop tubes provide stepless-speed control for either rotation.

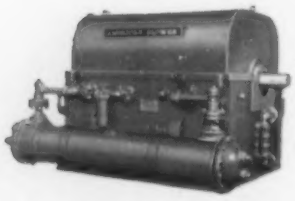
Choose the exact fluid drive you need!



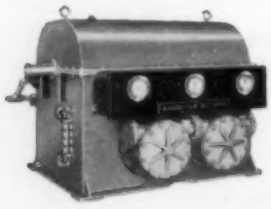
Type TM Gyrol Fluid Drive: motor, traction-type drive in a single unit; 1 to 20 hp; Bulletin 8519. Type T: traction-type less motor; ½ to 200 hp; Bulletin 7419.



Type VS, class-2, adjustable-speed Gýrol Fluid Drive. Speed range: 5 to 1. Six sizes, 7½ through 800 hp; speeds up to 1,800 rpm. Request Bulletins 9419 and 9519.



Type VS, class-4 Gýrol Fluid Drive — an adjustable-speed drive for fans, compressors and pumps, etc. 100 to 2,500 hp; speeds up to 1,800 rpm. Ask for Bulletin 9319.



Type VS, class-6 Gyrol Fluid Drive — adjustable speed drive for boiler-feed pumps, compressors, other high-speed applications. 400-12,000 hp; to 3,600 rpm. Bulletin 8019.

American Blower offers you a complete line of Gýrol Fluid Drives — including the new type VS, class-2, adjustable-speed model

Application possibilities are unlimited with American Blower's Gýrol Fluid Drive line!

For example, the new type VS, class-2, adjustable-speed Gýrol Fluid Drive can be reversed while in motion — at any adjustable operating speed — by merely changing the direction of rotation of the motor! And you can use this compact, self-contained unit in a variety of arrangements of the driving motor.

The standard Gýrol Fluid Drive line includes constant-speed and adjustable-speed units — up to 12,000 hp, and speeds to 3,600 rpm. You'll find there's a Gýrol Fluid Drive to fit practically any application.

For fact-packed bulletins and complete engineering data, get in touch with your nearest American Blower or Canadian Sirocco Branch Office; or write us direct. Do it, today!

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

Silicon steel laminations give high efficiency.
Hardened beryllium copper plunger guide reduces friction and wear.
Shock-absorbing bumpers cushion stroke, assure longer service.
Heavy Formvar insulated magnet wire on high flow point molded nylon bobbin.
Tempered steel spring absorbs vibration — holds assembly firmly in alignment.

Decco INDUSTRIAL SOLENOIDS

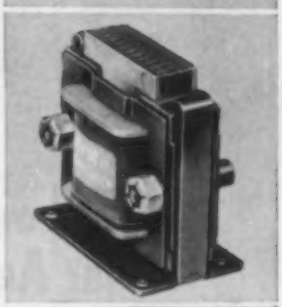
THE *Dependable* ANSWER TO YOUR SOLENOID PROBLEMS

- **COMPACTLY DESIGNED**—for powerful performance.
- **SHOCK-MOUNTED**—Reduces self-destruction—greatest cause of solenoid failure.
- **HIGH MOISTURE RESISTANCE**—Thoroughly impregnated with insulating baking varnish.
- **ALTERNATING CURRENT TYPES**—Welded base construction for horizontal mounting. Welded or shock-mounted base for vertical mounting. Available in standard voltages, push or pull types, J. I. C. specifications.
- **DECCO D.C. SOLENOIDS**—are *NOT* MODIFIED AC SOLENOIDS. They deliver a tremendous force in a small space—ideal for mobile equipment.
- **WAFER-TYPE SOLENOIDS**—Dependable, small, short stroke, low amperage, push or pull solenoids for small mechanisms and light valving.
- **SPECIAL SOLENOIDS ENGINEERED TO YOUR PROBLEMS.**

HORIZONTAL PUSH-TYPE— WELDED BASE

VERTICAL PULL TYPE— SHOCK-MOUNTED

VERTICAL PUSH TYPE— WELDED BASE



A C WAFER SOLENOID

D C INDUSTRIAL SOLENOID

FOR COMPLETE INFORMATION ON ALL DECCO INDUSTRIAL SOLENOIDS • WRITE:

Decco
THE HEART OF DEPENDABLE AUTOMATION EQUIPMENT

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

ELIMINATE REJECTS!
MINIMIZE BREAKAGE!

use Bird jewel assemblies

Why chance rejects and breakage that add to production costs when you can eliminate these time-wasting "headaches" with Bird complete jewel assemblies — ready to install in your equipment. Bird's many years of precision production mean jewel bearings of the highest quality These jewels are set according to your specifications by skilled craftsmen, in less time, for less money, and eliminate special set-ups in your plant.

Why not bring us your jewel problems — you specify — Bird will supply assemblies that fit your product and schedule. Our engineering staff is at your service for **all** your jewel bearing problems.

For information on jewel assemblies write for Bulletin 14.

Over 40 years of serving industry with Quality jewel Bearings

Richard H. Bird & Co., Inc.

Sapphire and glass jewels · Precision glass grinding · Ferrite precision products · Sapphire stylii

1 Spruce Street, Waltham 54, Mass.

Mr. Design Engineer:

Durakool is the Life of Your Automatic Controls

MILLIONS OF CYCLES WITHOUT FALTERING

This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes.

Send for Bulletin 525.

See telephone directory for local distributor, or write.

DURAKOOL, INC.

ELKHART, INDIANA, U.S.A. • 700 WESTON RD., TORONTO, CANADA

Durakool ALL-STEEL MERCURY *Switches*

Ceremonies. As he stood and delivered his preliminary speech, sitting alongside of him was Eugene Grace, Chairman of the Board of Bethlehem Steel. This occurred in the early Forties' when men of vision merely had to be wealthy to be called Economic Royalists and the American public was being propagandized into believing that any man of great wealth was of low estate.

In their college days, Tom Girdler was manager of the baseball team and Gene Grace played shortstop. Now Gene Grace was just as good a baseball player as he is a golfer. And that is saying a lot. He can do eighteen holes in just about the years of his age and few men can match such a performance.

In any event, coming back to this dinner, Tom Girdler in his typical fashion introduced Gene Grace as the speaker of the evening. And here is a small portion of what he said.

"Gene, I remember when you were playing shortstop in college you were offered a juicy contract to play in the big leagues. You turned down that contract. That was a hell of a mistake. Had you gone into professional baseball, you would now be a great national idol instead of a damn economic royalist."

Vaun Arnold spoke volumes in a twelve line poem. Orchids to him. I cannot imagine how his poem could be improved.

Recently there appeared in several publications articles in which Dr. Rudolph Flesch severely criticized educators who were teaching children to read by sight rather than by teaching them the phonetics of spelling. Indeed, this matter became quite an argument and I was very much amused. Both the pros and cons of this problem were correct but as far as I know neither side got at the root of the matter.

English is getting to be quite an old language. Perhaps too old and thereby it is getting creaky bones. When the word "knew" first came in the language is was not pronounced like "new" but it had a slight "k" sound before it, such as is still used on the stage. The same thing could be said of many many English words. Over the years their pronunciation changed and today they have little resemblance to the original. But the

(Continued on page 384)

ONLY NOELTING Faultless TRIPLE GREASE SEALED CASTERS

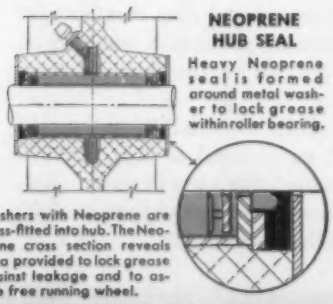
Have NEOPRENE VULCANIZED RETAINERS

(PATENT PENDING)

LEAK-PROOF NEOPRENE RETAINER MOLDED AND VULCANIZED ON UPPER BEARING SWIVEL RACEWAY. PATENT PENDING.

2 THRUST BEARING GREASE RETAINER TIGHTLY FITTED AROUND FORMED, HARDENED RACEWAY. CAN BE EASILY REMOVED FOR CLEANING OR INSPECTION.

3 NEOPRENE RING PERMANENTLY ATTACHED TO METAL WASHER AND PRESS FITTED INTO HUB.



NEOPRENE HUB SEAL

Heavy Neoprene seal is formed around metal washer to lock grease within roller bearing.

Washers with Neoprene are press-fitted into hub. The Neoprene cross section reveals area provided to lock grease against leakage and to assure free running wheel.

SERIES 900GS CASTER GIVES POSITIVE PROTECTION TO SWIVEL AND WHEEL BEARINGS WHEREVER STEAM, DIRT, CHEMICALS OR WATER ARE ENCOUNTERED

Ask your Faultless Distributor for further particulars and a demonstration, no obligation, or write to

1 Molded Neoprene grease seal is vulcanized to upper bearing raceway and snugly fits corrugated ring in top plate. Keeps lubricant in—keeps dirt and water out of swivel bearing. Top surface snaps back to snug fit after old grease is flushed out. Functions normally with standard grease in temperatures as low as 0°F. and as high as 200°F. (Also available with special grease for temperature range of −40°F. to 500°F.). *Permanent film of grease positively reduces friction and accelerates swiveling.*

2 Thrust bearing grease retaining cup provides no-leakage protection and keeps lower ball race free of dirt and moisture. Keeps swivel head lubricated indefinitely. Easily removed, as required.

3 Wheel bearing Neoprene seal is permanently attached to washer and press-fitted into hub. Keeps foreign matter out of roller bearings and ball bearings in hub. Locks in lubricant and assures free rolling of wheels.

4 Double ball bearing construction . . . two full rows of hardened, ground, and polished large diameter balls operate in smooth, lubricated raceways for effortless swiveling. All bearing surfaces hardened.

5 Handy pressure type grease fittings . . . same size for both swivel and wheel bearings. Fitting is permanently attached for life of caster. Easy to reach for fast, efficient maintenance. *No disassembly necessary for lubricating caster.*

6 Heavy gauge corrugated top plate . . . deeply embossed for maximum load capacity. Same size top plate and mounting hole c-c in all sizes of both rigid and swivel casters in this Series. Available in 3 different top plate and mounting hole c-c sizes, in 900GS Series Swivel Plate Casters.

7 Case hardened raceways . . . all bearing raceways are full hardened for years of trouble-free swiveling action. Top ball race welded to caster horn. Lower ball race accurately machined from solid steel bar stock. Precisely formed and fully hardened ball retainer with deep skirt fitted around balls in thrust bearing for high efficiency and long life.

8 Heavy gauge caster horn . . . full drawn steel horn will not bend under maximum loads.

9 Large diameter king pin . . . securely holds top plate and machined lower ball race cone in perfect alignment.

10 Wide choice of Faultless Wheel diameters and treads for load ratings up to 650 pounds per caster.

FAULTLESS CASTER CORPORATION, EVANSVILLE 7, INDIANA

Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Houston, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, St. Louis. Canada: Stratford, Ont.

Thermoid Friction Materials fit into your designs perfectly because they're custom-engineered to your exact specifications.

In Clutches manufactured by Twin Disc Clutch Co., Racine, Wisc., two Thermoid Clutch Facings, developed from superior compounds, provide smooth, positive engagement with minimum wear.

Leading manufacturers coast to coast have found it pays to specify Thermoid Friction Materials—not only for quality, but for Thermoid's *Personalized Engineering Service.* Thermoid is big enough to handle mass production demands . . . small enough to assure close liaison with your engineering staff.

Look to Thermoid, too, for Fan Belts, FHP Belts, Flat Belting, Radiator Hose and Hose of any type—designed to fit your most exacting requirements.

Thermoid

Thermoid Company
Original Equipment Division
Trenton, New Jersey

spelling remained the same. Hence the word that was originally spelled phonetically is no longer spelled phonetically, so that enough became enuf. And mixing Celtic, Saxon and French words did not help. Hence we have the situation that a portion of the English language is spelled in Chinese fashion and another portion is spelled phonetically.

How The Chinese Do It

To teach the little boys and girls that eight is not spelled ate we must resort to the Chinese method. In the Chinese grade schools, as described to me some years ago, they give each child a card with ten or a dozen words written on it and the child is required to stare at these words or symbols until he has memorized their "spelling." And so it goes. Presumably it would be possible to teach the school children in America to spell according to sound all the phonetically spelled words and then group all of the other words to be learned by sight reading. Then both Dr. Flesch and the educators with whom he is arguing might be satisfied.

Chinese writing is to some extent a picture language. A few of the words are easily learned. For example the word "man" is almost exactly like the Greek letter lambda, λ. It is supposed to represent a man without arms or rather a man with his arms at his side and hence not visible. Thus we have a crude picture of a man meaning the word man.

Now in China there is a tradition, or perhaps only a fable, that at one time the country was so honest that if a man through carelessness or oversight committed an offense of any kind he might be sentenced to a few days in jail. Instead of putting the man inside of an enclosure the man was taken to a certain place and lines marking off a square were scratched in the ground around him. According to the fable, even the offenders were so honest that they would remain inside the square and thus the Chinese word meaning prisoner is pictured as a man with a square drawn around him.

Now if the written Chinese words were all as pictorial as that I think even I could learn a few of them. But the pictures soon get rather complicated so that lets me out. G.F.N.

ABSTRACTS

Program in Ergonomics

Abstracted from "Proposed Program in Ergonomics . . . Human Engineering," by Theodore F. Hatch, Prof. of Industrial Health Engrg., Univ. of Pittsburgh, Pittsburgh, Pa.; *Mechanical Engineering*, May 1955.

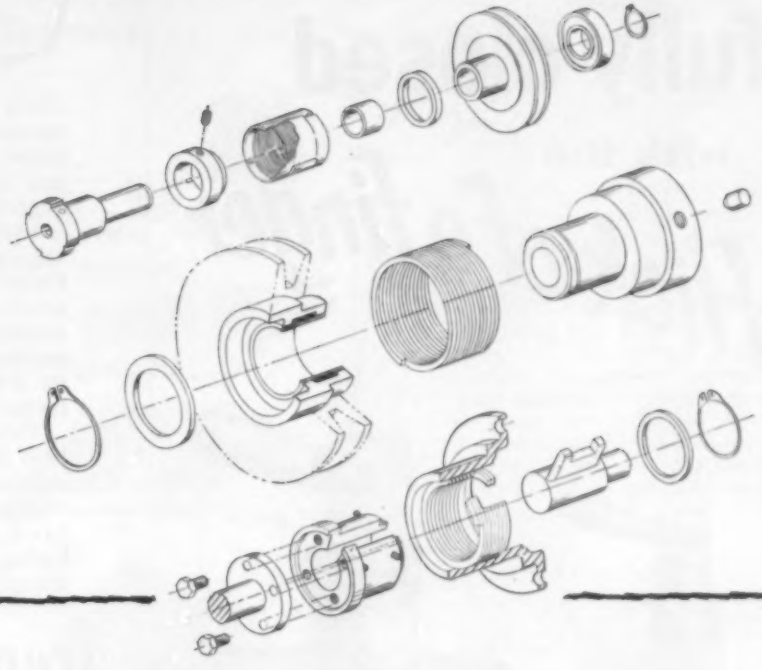
Originally, human engineering had to do with the management of people, with no reference to the physical aspects of engineering. In its popular use, the term lost standing altogether among engineers. It is given a new and specific physical meaning here, however, which should be entirely acceptable. Human engineering is defined as "the application of the principles, laws, and quantitative relationships which govern man's response to external stress, to the analysis and design of machines and other engineering structures, so that the operator of such equipment will not be forced to operate at less than its full capacity in order for the operator to stay within acceptable limits of human capabilities."

This definition implies, that, to a useful degree, man's anatomical, physiological and psychological capacities and limitations can be expressed in the systematic terms of engineering and that the nature, source and magnitude of stresses set up by the machine can be identified and measured and even ancipiated in the course of design of a new machine so that the operator will not be subjected to too much stress. Thus in their fullest development, the laws which govern man's working capacities will be applied by engineers on a par with physical laws in engineering practice.

It is proposed that the ASME set up a working committee on ergonomics to explore this field, to develop a body of principles, laws and data for use by design engineers, and to demonstrate the practical usefulness of this area of specialization in the solution of important human problems in industry. This committee should include engineers representing different fields of concern: industrial engineering, time-and-motion study, methods engineering, machine-tool design, plant layout and building

(Continued on page 387)

When you need a clutch...



check into the many advantages of Marquette SPRING CLUTCHES

OVER-RUNNING or FREE-WHEELING CLUTCHES • INDEXING CLUTCHES
BI-DIRECTIONAL NO-BACK BRAKES • REVERSING CLUTCHES
SINGLE REVOLUTION CLUTCHES • DELAYED ACTION CLUTCHES

LOW COST • COMPACT • TROUBLE-FREE

Marquette Spring Clutches have given dependable service for many years in a wide range of applications—from Aircraft to X-ray. They require very little space. They maintain their efficiency almost indefinitely. And they cost much less than other types of clutches.

Send today for your copy of illustrated manual that gives helpful data on Marquette Spring Clutches!

The Marquette METAL PRODUCTS CO.
SUBSIDIARY OF CURTISS-WRIGHT CORPORATION
ALSO MANUFACTURERS OF: ROLLER BEARING TEXTILE SPINDLES
HYDRAULIC GOVERNORS • PRECISION PARTS AND ASSEMBLIES
AIRCRAFT WINDSHIELD WIPERS • FUEL OIL PUMPS & INJECTORS
ROTARY HIGH PRESSURE OIL FIELD PUMPING MACHINERY

A PRODUCT OF CW CURTISS WRIGHT

THE MARQUETTE METAL PRODUCTS CO.
1143 Galewood Drive, Cleveland 10, Ohio

Please send manual describing the functions, applications and operations of the basic types of Spring Clutches.

COMPANY_____

NAME_____ TITLE_____

ADDRESS_____

fully-opened... fully-closed

with the

flick of a finger

HOKE toggle valves

Hoke toggle valves open and close with a single, positive motion like flipping a light switch. Use them on your precision test equipment for gas or liquid control at pressures up to 1000 psi. Seat and stem seals are tight enough for most high vacuum work.

In instrument panel service you can tell instantly that the valve is open (or closed) and the colored nylon handles identify fluids at a glance.

Available in angle and globe patterns in brass or stainless, ⅛" through ½" pipe (or with tube fittings).

May we send you catalog and data sheets?

HOKE INCORPORATED

Fluid Control Specialists

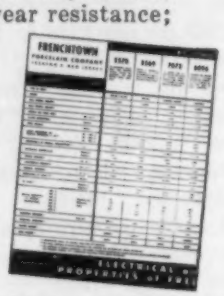
197 S. DEAN STREET, ENGLEWOOD, NEW JERSEY

WANTED!

We're looking for engineers whose prime responsibility is to seek ways and means to make products or parts better, more efficient and at lower cost. To you, we recommend Frenchtown *engineered* ceramics.

Very possibly you can profit from the many valuable properties of Frenchtown *Engineered* Ceramics to give you resistance to *high temperatures* and low thermal expansion; excellent mechanical strength and wear resistance; superior dielectric strength at both high and low frequencies.

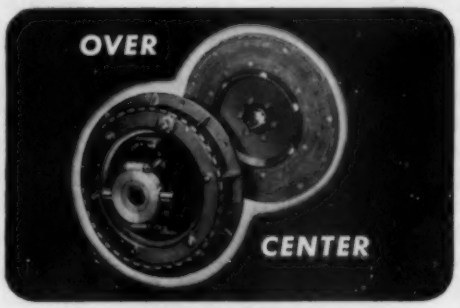
This helpful 4-page bulletin contains complete data on electrical and mechanical characteristics of Frenchtown high-performance bodies. Send for a free copy today.



frenchtown PORCELAIN COMPANY

87 Muirhead Avenue | Trenton 9, New Jersey

ROCKFORD



POSITIVE ENGAGEMENT

EASY OPERATION
HIGH TORQUE
POSITIVE ENGAGEMENT
LARGE DRIVING AREA
SMOOTH RUNNING
INFREQUENT ADJUSTMENT
MINIMUM INERTIA

• ROCKFORD Over-Center CLUTCHES remain in or out of engagement until changed by the operator. The smooth, easy, anti-friction engagement—obtained by roller cams pressing against the pressure plate face—progresses from "release" to "on center" to slightly "over center" where the clutch locks in engaged or running position.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

BW

ROCKFORD CLUTCH DIVISION BORG-WARNER

▲ 209 Catherine Street, Rockford, Illinois, U.S.A. ▲

CLUTCHES

design, health and safety engineering. The ASME should invite specialists from the fields of anatomy, physical anthropology, biomechanics, and various branches of applied psysiology and applied psychology to serve on the committee. The immediate objectives would be to define more sharply the nature of human problems which require attention; to bring together existing information on human capabilities and limitations from the parent fields of biological and social science and show how this information can be translated into physical terms for use in engineering design; and finally, to outline the needs for research and joint study of human problems arising out of mechanization in industry so as to establish the fields of ergonomics and human engineering on a firmer and broader basis. It is believed that the work of this committee will contribute in an important way to meeting a recognized need and responsibility in industrial engineering practice.

Photo-Lofting

Abstracted from "Photo-Lofting," by Albert A. Smith, Production Engr., (Naval Architect), Project Engr. for Photo-Lofting, Bureau of Ships, *Bureau of Ships Journal*, June 1955.

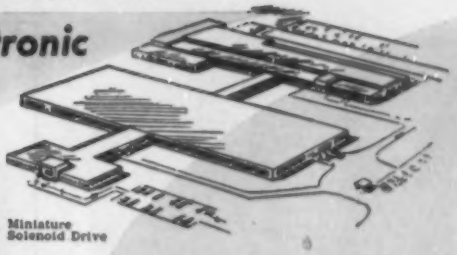
This process, as adapted by the Bureau of Ships, includes three major steps: (1) precision drafting on dimensionally stable materials; (2) photographic production of negatives of these drawings; and (3) through the same lens and camera, production of full-size pictures of the drawing on either template material or on the workpiece by projection from the negatives.

The maximum size of picture obtainable in the Bureau installation is 16 x 5 ft, so that a combination of four pictures will be adequate to produce a template of, say, a shell plate approximately 30 x 8 ft in size. Conversely, intricate drawings can be made at enlarged scales and reduced to actual size.

In photo-lofting, the first essential is to make the original drawings on what are called stable materials; tempered masonite, metal sheets, and glass cloth have been used. Given the assurance that whatever is drawn on stable material will remain true

(Continued on page 388)

Sub-miniature Assemblies To Gigantic Electronic Systems.....

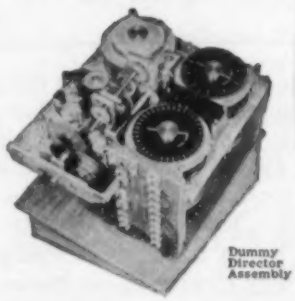


Miniature Solenoid Drive

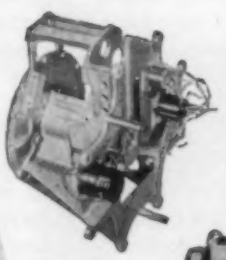
Miniature Gear Reduction Unit

Sub-miniature Circuits —Transistorised Application

Tuning Drive Assembly



Dummy Director Assembly



Antenna Drive Housing

Alternate Fire Control

Mark 56 Director

DAYSTROM INSTRUMENT has produced tiny precision assemblies . . . to gigantic gun directors and fire control systems — all within their modern 350,000 sq. ft. plant. When you combine Daystrom's team of skilled engineers with efficient production methods and modern facilities, you'll understand how Daystrom has been able to achieve mass production of such products—on time and at low cost—for every branch of the Armed Forces and industry.

. . . For the NAVY

Radar Fire Control Systems, Mine Detecting Devices, Anti-Submarine Attack Directors, Catapult Speed Indicators, Servo Control Systems, Torpedo Assemblies.

. . . For the AIR FORCE

Capacitance Testers, All-Altitude Servo Indicators, Transistorized Receivers, R F Switches, Potentiometers.

. . . For the ARMY

Mechanical Fire Control Systems, Fuzes, Communication Systems and other instrumentation for all branches of the Army.

. . . For INDUSTRY

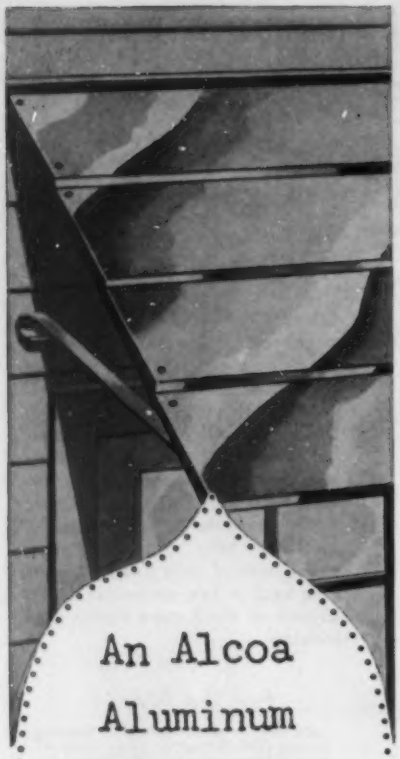
Test Equipment, Computing Devices, Radar Equipment, Nuclear Equipment, Gyro Mechanisms, Electronic and Electro-Mechanical Devices.

Write For Our Facilities Report

DAYSTROM INSTRUMENT

ARCHBALD, PENNA.

Div. of Daystrom, Inc.



An Alcoa Aluminum Fastener should be used here!

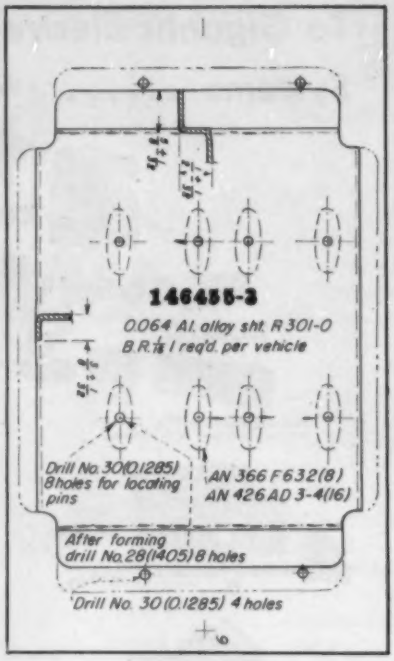
It's an aluminum awning assembly, worth the lasting strength of Alcoa® Aluminum Fasteners. You avoid galvanic and atmospheric corrosion. You get perfect color match; you get the very highest quality product. Your local Alcoa distributor has a complete stock.

P. S. In this awning assembly, we suggest an aluminum sheet metal screw from Alcoa's complete line of aluminum fasteners.

Aluminum Company of America
2247-L Alcoa Building, Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

name_____
title_____
company_____
address_____

Always Fasten Aluminum with Alcoa Aluminum Fasteners


146455-3
0.064 Al. alloy sht. R 301-0
B.R. 1/8 I req'd. per vehicle
Drill No. 30 (0.1285) 8 holes for locating pins
AN 366 F 632 (8)
AN 426 AD 3-4 (16)
After forming drill No. 28 (.1405) 8 holes
Drill No. 30 (0.1285) 4 holes

to size, the next essential is the production of drawings that are accurate. It was found that accuracy within 0.010 in. was readily obtainable and, when required, that 0.005 in. was obtainable. This type of drafting became known as 'precision drafting."

A costly element in the Bureau installation is the camera lens. It is guaranteed to produce a full-size picture to within $\frac{3}{64}$ in., which removes the possibility of further error in the reproduction process.

The stable material selected was aluminum alloy sheet of 0.050 in. thickness. This material was purchased in 15 x 4 ft sheets. To prepare the surface for drafting, the surfaces are cleaned and degreased prior to painting with the primer coat. The spraying is done automatically, and the plate proceeds by overhead track through the baking oven for proper drying.

Up to four coats of special paint to give body to the drawing surface are applied, and a final color, easy on the eyes of the draftsmen, is applied. Pale green has been found to be excellent and it has the added advantage of not reflecting a halo during photographing.

Sheets used for templates are not colored because the white coat gives the best definition to the picture when developed. In use, the sheets for drafting are routed to the drafting office, where the design is cut into

(Continued on page 390)

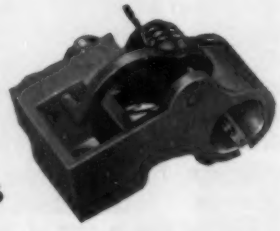
pick your EXACT type BRUSH HOLDER

We design them FOR....

- INDUSTRIAL MOTORS
- CRANE MOTORS
- HOIST MOTORS
- MILL MOTORS
- MINE MOTORS
- CONTROLLERS
- ROTARY CONVERTERS AC-DC
- RAILWAY MOTORS

3086

2981



3076

When your specifications demand BRUSH HOLDERS with high wearing qualities, low maintenance cost – pick from our more than 1,000 types, or have our engineers design your special type. These special designs shown are three of many produced for specific applications. . . . . The 'something special' in BRUSH HOLDERS is produced by the specialist. Ask FLOWER

WRITE FOR CATALOG 4-P

FLOWER

D. B. FLOWER MFG. CO.

1217 Spring Garden Street, Phila. 23, Penna.

WAUKESHA has the CORROSION-RESISTANT METALS to make the Quality Castings you need

to help solve your tough product design problems

SELECT FROM AMONG THESE TYPICAL WAUKESHA FOUNDRY METALS

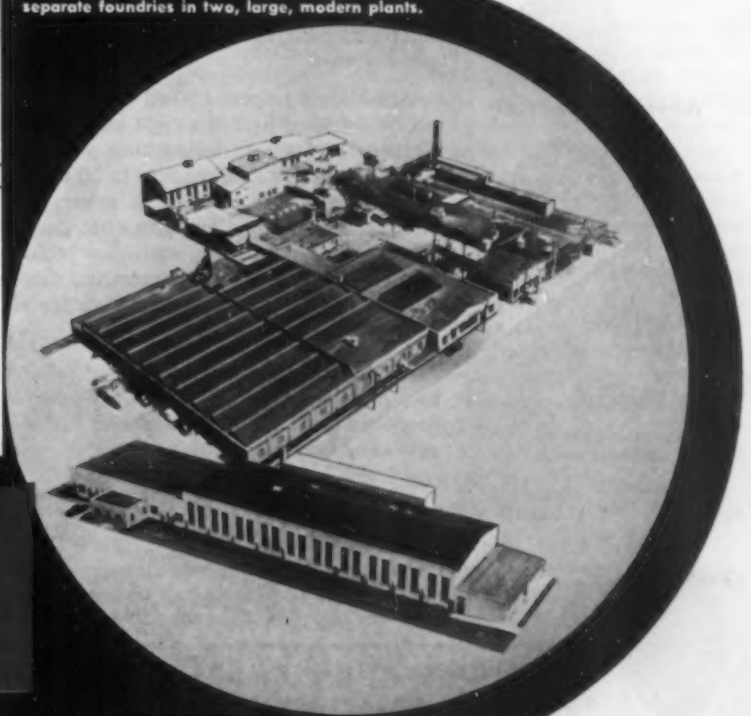
TYPE	Description and Application
STAINLESS STEEL	
GROUP I	Martensitic—straight chromium, hardenable. Machineable. Weldable. Magnetic.
403	High stress rotating parts. Turbine blades.
410	Valve trim, oil refinery equipment, pump shafts.
416	Pinions, gears, shafts, aircraft fittings.
GROUP II	Ferritic—straight chromium, non-hardenable. Machineable. Magnetic. Corrosion resistance superior to Group I.
430	Trim work exposed to atmosphere or water. Hardware.
442, 3, 6	Scale resisting. Furnace parts, baffles, blowers, trays.
GROUP III	Austentic—chromium—nickel—non-hardenable.
302	Heat treating fixtures.
303	Food machinery equipment.
304	Dairy equipment. Magnetic traps.
305	Textile equipment.
309	Chemical equipment. Pump parts.
316	Chemical equipment. Condensers.
347	Pressure fittings.
WAUKESHA METAL	
0	Copper base, high nickel content, corrosion-resisting alloy. For high hardness. High tensile characteristics. Good wearing qualities.
1	Recommended for frictional parts.
3	Rather hard. Recommended for conveyor chain links, cams.
18	Recommended for use on shafts and applications involving pressure and high tensile strength.
23	Bearing alloy to be used in conjunction with stainless steel alloys for non-galling applications.
NON-FERROUS METALS	
Monel	Developed to meet requirements for specific application of corrosion resistance and bearing qualities.
Pure Nickel	Very high corrosion resistance.
Inconel	For specific corrosion resistance applications.
Aluminum Bronze	Exceptional bearing qualities, used where parts may be subjected to impact.
Everdur	Silicon bronze alloy. Corrosion resistance properties of copper and physical properties of mild steel.
Brass and Bronze	All grades available.
Aluminum	Alloys to meet all specifications available, including heat treat alloys.

Why Waukesha-Created Metals: To solve the manifold problems confronting engineers, Waukesha has mastered the foundry techniques of a wide variety of corrosion-resistant metals to meet present day casting design needs for equipment in many industries. If yours is a corrosion-resistant casting design problem of hardness, strength, elongation, wear resistance, bearing qualities, impact, scale resistance, seizing or galling, or intergranular corrosion among others—Waukesha has the metal and the casting know-how to solve it.

Quality Control: Metallurgical laboratory control of every production step, top engineering casting design, and skilled craftsmen guarantee you castings that are uniform, close-grained, free of porosity, metallurgical accurate in composition, and dimensionally correct . . . castings precisely to specifications . . . castings that stand up to the severe demands of today's designs.

Waukesha has the facilities to supply your production casting needs on schedule. We suggest that you write, today, for a casting quotation or engineering counsel on your casting designs. Waukesha Foundry Company, 5503 Lincoln Avenue, Waukesha, Wis.

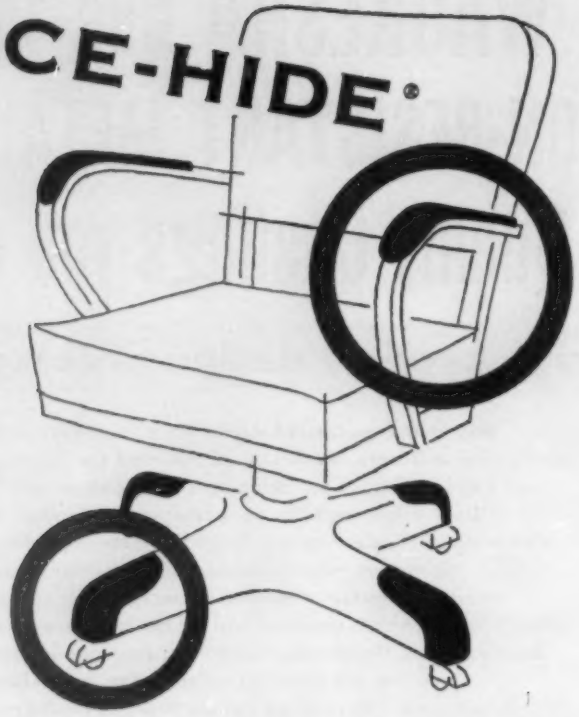
Waukesha operates three distinct and separate foundries in two, large, modern plants.



Waukesha Foundry Company
WAUKESHA, WISCONSIN

WAUKESHA: *SPECIALISTS IN CORROSION-RESISTANT CASTINGS FOR ALL INDUSTRIES*

ACE-HIDE®



the new molding material that's both **TOUGH** *and* **GENTLE**

Ace-Hide acid pail

Molded top for golf bag

Large molding is lid for beverage cooler

Ace-Hide is a new rubber-plastic molding material designed to take a beating without showing it. Its toughness, smoothness, resilience and excellent chemical resistance have already led to wide-spread use for things like chair arm pads, scuff guards, acid pails and golf bag tops.

Ace-Hide is a special blend of rubber with plastic, hence is light in weight and has good electrical and thermal insulating properties. Rigidity and impact strength (to 10.0 Izod) can be varied to suit. Takes inserts well. Surface is smooth, shiny. Does not develop flexing cracks, and ages well. Ace molding facilities offer wide range of sizes and shapes. We'll be glad to make specific recommendations. Write today.

Ace-Hide and many other hard and soft rubber, plastics, and rubber-plastic blends are described in 80 pg. ACE Handbook. Write for your copy today!

ACE® rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

the paint film. Very hard pencils—up to 11H—have been used. They are sharpened to a thin chisel point to give the least reflection of light when the negatives are being made. A conical point leaves a V-shaped cut in the paint film, and light reflected from inside the V results in blurred instead of sharply defined lines.

When the design is finished, a negative is made—at present on glass. From this negative any required scale, either an increase or a decrease, is projected onto template sheets previously coated with a photographic emulsion.

Following usual procedures, the exposed sheets are passed through a developer, a short stop, a fixing and washing sequence and are dried. Then they are ready for shipping to the fabrication shop.

Collateral benefits for design have not been fully explored, but it is obvious that models of any scale can be produced photographically from a set of lines at another scale without drawing an additional line. Transparent overlays can be readily produced for resolution of interferences at a common scale from drawings at different scales by simple photographic means.

To return to the first drawing, note the information supplied: piece number, material, direction of flange turns, size and location of holes, sequence of operations, and check points 9 in. apart. Other information contained in the full photograph, but not shown in the illustration, includes rivets, other plates, plate assembly, name of part, where used, size of blank required, accounting information, authority, and master check dimension for camera operator. All the required information is here and can be repeated the required number of times necessary without use of dimensional transfer.

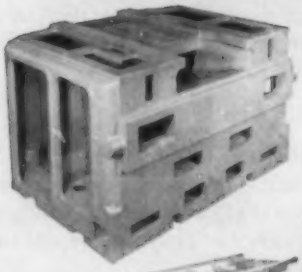
Mechanical Sampling Devices In Telemetering

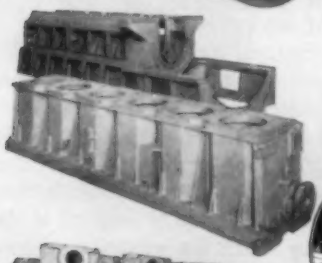
Abstracted from "Mechanical Sampling Devices in Telemetering and Related Fields" by J. F. Brinster, President, General Devices, Inc., Princeton, N. J.; presented at 1955 National Telemetering Conference, May 18-20, Chicago, Il.

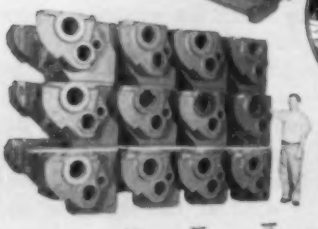
It has become increasingly important in multi-channel instrumentation to use simple compact switching devices capable of connecting one or more circuits to a multiplicity of circuits in

(Continued on page 392)

Steel-Weld FABRICATION







Use WELDED STEEL for Greater Strength with Less Weight!

If you use weldments, or are contemplating their use, you are a potential customer of The R. C. Mahon Company. If you require parts or assemblies, including large, heavy pieces, where time and pattern cost are a consideration, you can turn to Mahon with complete confidence. Mahon's service to users of welded structural or heavy plate fabrications is complete from design or redesign to finished machining and assembling. Illustrations on this page are typical of thousands of parts and assemblies produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. If you need weldments, or welded steel in any form, you, like hundreds of others, will find in the Mahon organization a unique source . . . a source where design skill and advanced fabricating techniques are supplemented by craftmanship which assures you a smoother, finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or write for Booklet showing Mahon's facilities to serve you.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES ENGINEERING OFFICES in NEW YORK and CHICAGO

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

put FESCO BOARD* between you and your problem

*rigid, light insulation board for thermal and moisture control

Fesco Board offers product designers this unique combination of properties:

- **High insulation efficiency** — "K" factor of .29 to .31 @ 75°F.
- **Fire-proof**—mineral composition, won't burn
- **Permanent** — won't rot, mildew or deteriorate
- **Moisture-resistant** — cellular glass membranes block moisture penetration
- **Structurally strong** — rigid, stable, yet easily cut for production sizes
- **Analysis** — composed of expanded Coralux perlite, mineral binders, and fibers
- **Lightweight** — weighs only .8 lbs. per board foot

Write for sample, additional technical data or laboratory assistance.

F. E. SCHUNDLER & CO., INC.
504 Railroad Street,
Joliet, Illinois

rapid sequence. It is practical to do this by means of direct electrical contact using multichannel switches of the mechanical type rather than by indirect switching, even at high speeds.

Typical requirements for the high speed sampling switch are: high sampling rates, good timing accuracy, maintenance-free life, capability of switching low voltages and currents, a large number of independent contacts, a number of mechanically synchronized poles, and satisfactory operation under conditions of elevated temperature, shock and vibration.

Basic Switch Types

High speed sampling switches are constructed in a variety of sizes and shapes and often integrated with associated devices. They can be classified as follows:

1. Motor-driven switch with integral worm gear reduction.
2. Switch without motor but with worm gear reduction.
3. Motor-driven switch with spur gear reduction.
4. Motor-driven switch with planetary gear reduction.
5. Direct motor-driven switch without gear reduction.
6. Switch without motor designed for external drive.

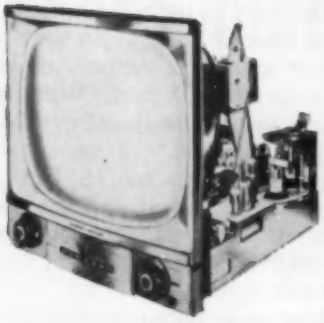
Most of these types can be constructed using a multiplicity of poles concentrically arranged on a single contact plate, or a multiplicity of stacked poles or decks.

In the most basic form of multiplex telemetry two remotely located sampling switches are arranged to operate in synchronism. The wipers operate in fixed phase relationship so that information sampled at the transmitting switch is distributed or selected at the receiving switch for whatever purpose it is to be used.

In radio telemetry the two switches are connected by unidirectional radio link, whereas in wired telemetry they are connected by an electrical conductor. In practice an electronic switch is often used at the receiving end. Where two or more mechanical switches are motor driven from the same power line it is often possible to operate them in mechanical synchronism with good phasing accuracy. This may be done by use of polarized or salient-pole synchronous motors operating at the line frequency. Where

(Continued on page 394)

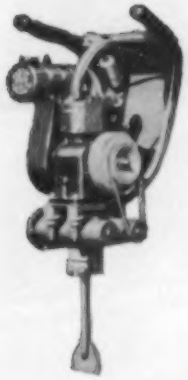
Everlock®



Admiral

Placed at strategic spots throughout the chassis, EVERLOCK lockwashers keep Admiral TV sets tight—permanently.

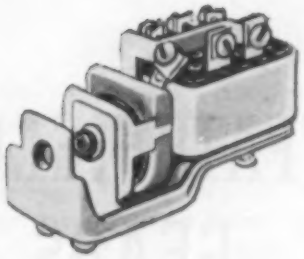
Everlock®



MASTER TAMPER

8650 jolts per minute, hour after hour, can't shake loose the EVERLOCK lockwashers on the Master Tamper.

Everlock®



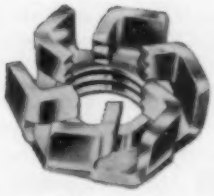
R-B-M SWITCHES

Specially designed EVERLOCK lockwashers provide permanent, vibration-proof fastenings on R-B-M automotive foot dimmer, headlamp and horn switches.

Everlock®... In the Picture

Wherever Positive Grip Counts

Lockwashers



Locknuts

Screw-Lockwasher Assembly

Another AMF Product
Everlock
INDUSTRIAL FASTENERS

EVERLOCK lockwashers' exclusive alternating chisel edges bite into the face of the work *and* the nut under powerful spring tension . . . hold fast even under the most severe jars, jolts and vibration. Available in four standard types or to your own specifications, EVERLOCK lockwashers provide the positive holding power demanded by more and more manufacturers of quality products. Next time you order lockwashers be sure to specify AMF EVERLOCK.

THOMPSON-BREMER & COMPANY,
516 N. Dearborn, Chicago 10, Ill.

Kenneth D. Delanoy Dayton 3, Ohio	J. M. Murphy Manchester, Conn.	W. L. Barth, Jr. Chicago 34, Ill.	Thom Lundeen Moline, Illinois	Richard C. Dudek Beverley Hills, Calif.	J. J. McIntosh Atlanta 6, Ga.
Oscar P. Martin Lakewood 7, Ohio	Russell T. Brosius Philadelphia 3, Pa.	C. W. McNeil Houston, Texas	Forrest Moschner St. Louis, Missouri	P. L. Robertson Milton, Ont. Can.	Donald G. Teeling Indianapolis 44, Ind.
J. Ramsey Reese, Inc. New York 7, N.Y.	Sam T. Keller Detroit 1, Mich.	Leonard F. Berg St. Paul 14, Minn.	A. J. Murphy DeWitt, N.Y.	Sam T. Gleaves Louisville 5, Ky.	Oregon Indus. Factors Portland 1, Oregon

For
A BETTER PRODUCT...

... USE
FAIRFIELD GEARS

★ If GEARS are a vital part of the product you make, there is no finer recommendation for the QUALITY of your product than to be able to say it is equipped with "FAIRFIELD GEARS."

Long producers of the gears needed in high grade trucks and tractors, Fairfield now brings the same standards for GEAR PERFORMANCE to a wide variety of products: Agricultural Implements ... Power Shovels ... Machine Tools ... Diesel Locomotives ... Road Graders ... Lift Trucks ... Road Rollers ... Pump Drives ... Winches ... Military Vehicles ... and a host of others.

Fairfield's facilities are unexcelled. Here "under one roof" in a new and ultra modern plant designed especially for the purpose, Fairfield has everything needed for producing all kinds of gears: spur ... herringbone ... spiral bevel ... ground tooth spiral bevel...straight bevel...coniflex bevel...hypoid...zerol...worms and worm gears...splined shafts...differentials. Get acquainted with Fairfield's engineering and production facilities. Your inquiry will receive prompt attention. FAIRFIELD MANUFACTURING COMPANY, 2305 South Concord Road, Lafayette, Indiana.

Fine Gears Made to Order

FAIRFIELD

LAFAYETTE INDIANA

the switches are operating at a submultiple of the line frequency one of many known means of accurate framing is used.

Electrical and mechanical operation of the switch are related. If the force of the wiper on the contact pins is too light, contact resistance is high and timing accuracy or certainty of waveform is relatively poor. With large forces, particles are more quickly removed from the wiper or contacts, causing premature failure. This may also result in low inter-contact insulation resistance because of the deposit of conducting particles in and around the unit.

Most wiper designs involve the use of a cantilever arm to which a wiping contact is attached. This leads to difficulty in choosing the proper brush force, which varies greatly with even a small amount of wear. Furthermore the rate-of-wear as well as the time of maximum wear involves several factors and varies. Frequent adjustments are required during long service.

Fabrication of Titanium Components

Abstracted from "Fabrication of Titanium Components," by Arnold S. Rose, Supervisor, Research & Development Lab., I-T-E Circuit Breaker Co., Philadelphia, Pa., *Jet Propulsion*, May, 1955.

Fabrication of titanium may be divided into two phases. One concerns the commercially pure and alloy grades which are weldable; the other, those high-strength alloys which because of this composition are considered not capable of being welded. Only the weldable grades are considered here.

Commercially pure titanium at room temperature and at temperatures up to approximately 1600 F exists in a hexagonal close-packed crystal structure, the alpha phase. This structure allows the material to be bent and formed with some effort at room temperature although heating to approximately 1000-1200 F increases its ductility measurably. This, in combination with the drop in yield strength at elevated temperatures, greatly improves the formability. Inasmuch as these grades transform to the ductile alpha state at room temperature, no difficulty is experienced with post-welding embrittlement.

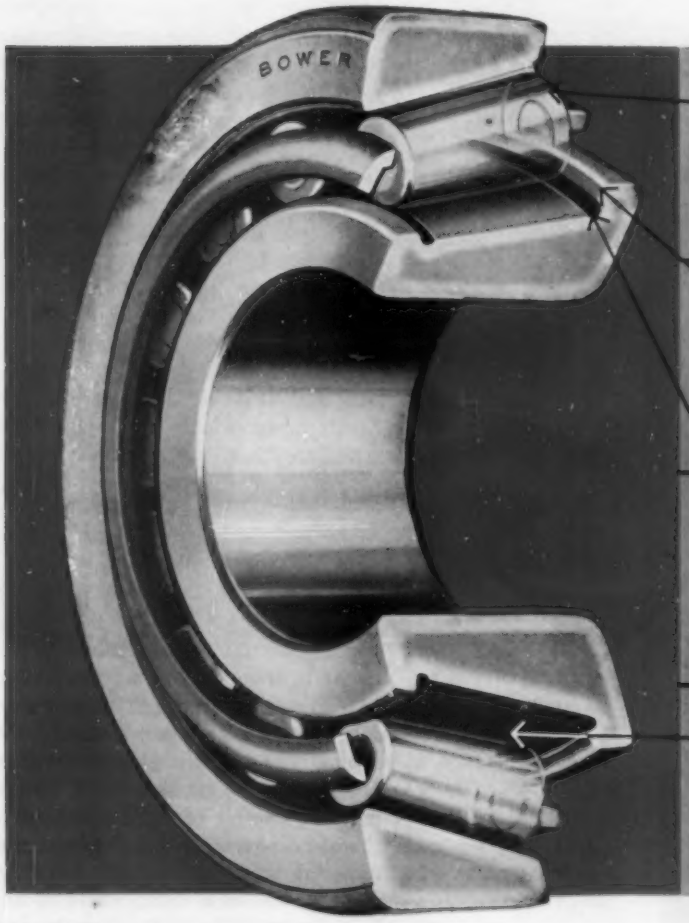
A recently developed variation from

(Continued on page 396)

Here's how BOWER Spher-o-honed design lengthens bearing life... cuts maintenance costs!

The Bower tapered roller bearing design features shown on this page are vitally important to every bearing user. For they illustrate the high quality, precision workmanship and close attention to engineering detail that go into *every* Bower bearing. Even more important, these Bower design features will give you significant bearing advantages such as reduced wear, longer bearing life and lower maintenance requirements. They've been thoroughly *proved* by extensive use in virtually every type of bearing application. If your product uses bearings—whatever it may be—specify Bower now. Or better yet, call in a Bower engineer while your product is still in the blueprint stage.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.



● **SPHERICAL ROLLER HEADS ARE GENERATED TO THE CONTOUR THEY ACQUIRE IN THE COURSE OF WEAR.** This helps Bower bearings hold adjustment and pre-load longer and better. Normal running-in time is virtually eliminated.

● **HIGHER FLANGE PROVIDES A LARGE, TWO-ZONE CONTACT FOR ROLLER HEADS,** thereby reducing unit pressure. This exclusive Bower feature improves roller alignment, greatly reduces wear and practically eliminates resultant "end play."

● **LARGER OIL GROOVE GIVES POSITIVE LUBRICATION** at the critical point—where the roller head thrusts itself against the cone flange. Here Bower design provides a larger recess that holds a generous supply of lubricant—increasing efficiency and decreasing supply of lubricant—increasing efficiency and decreasing wear.

● **PRECISION RACES PROVIDE QUIETER, SMOOTHER OPERATION.** A Bower-developed grinding and honing process provides a micro-smooth surface of hard, crystalline base metal. In this way, close-tolerance precision is built-in to stay! No final adjustment is needed!

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER
ROLLER BEARINGS

SPHER-O-HONED

This radar wave-guide throat section is cast of aluminum by the Antioch Process*. The specifications are rigid, but we meet them in production. Sample: center walls only .032" thick—inside finish meets electrical specifications as-cast.

The piece weighs 20 pounds and stands a foot and one-half high. Bean specializes in casting wave-guide, impellers and other parts of aluminum to demanding standards. Write for the Bean portfolio of difficult casting case histories. Or send a part print for recommendations.

Morris Bean & Company
Yellow Springs 3, Ohio

*Technical literature about the Antioch Process will be sent on request.

antioch process casting

the commercially pure titanium is an all-alpha phase weldable alloy containing 4 per cent aluminum and 2 per cent tin, Rem Cru's A-110AT grade. This alloy, whose properties at elevated temperature are superior to the commercially pure grades, is readily weldable and amenable to fabrication. Its superior properties make it more difficult to bend and form than commercially pure grades, requiring somewhat higher fabrication temperatures to achieve comparable metal movement. When proper consideration is given to this factor in design no difficulty should be experienced.

Bending and rolling of sheet and bar stock has been performed on rollers and mills commonly found in a stainless steel sheet metal shop, and forming of parts has been almost exclusively with Kirksite dies on a drop hammer. Sheet metal RC-A70, varying in thickness from 0.025 to 0.140 in. has been rolled into cylinders and conical sections with diameters ranging from 10 to 48 in. These have been rolled at room temperature with no difficulty. Sheet titanium 0.180 in. thick and bar stock ranging in section between ½ x ½ in. to 3 x 4 in. have required hot rolling. This was done by placing the flat stock into a 1300 F recirculating air furnace and holding for a length of time sufficient only to uniformly heat the material which was then transferred to the rolling machine. Surface pyrometer observation disclosed that even the heaviest bar sections were rolled into rings at temperatures varying from 900 to 700 F.

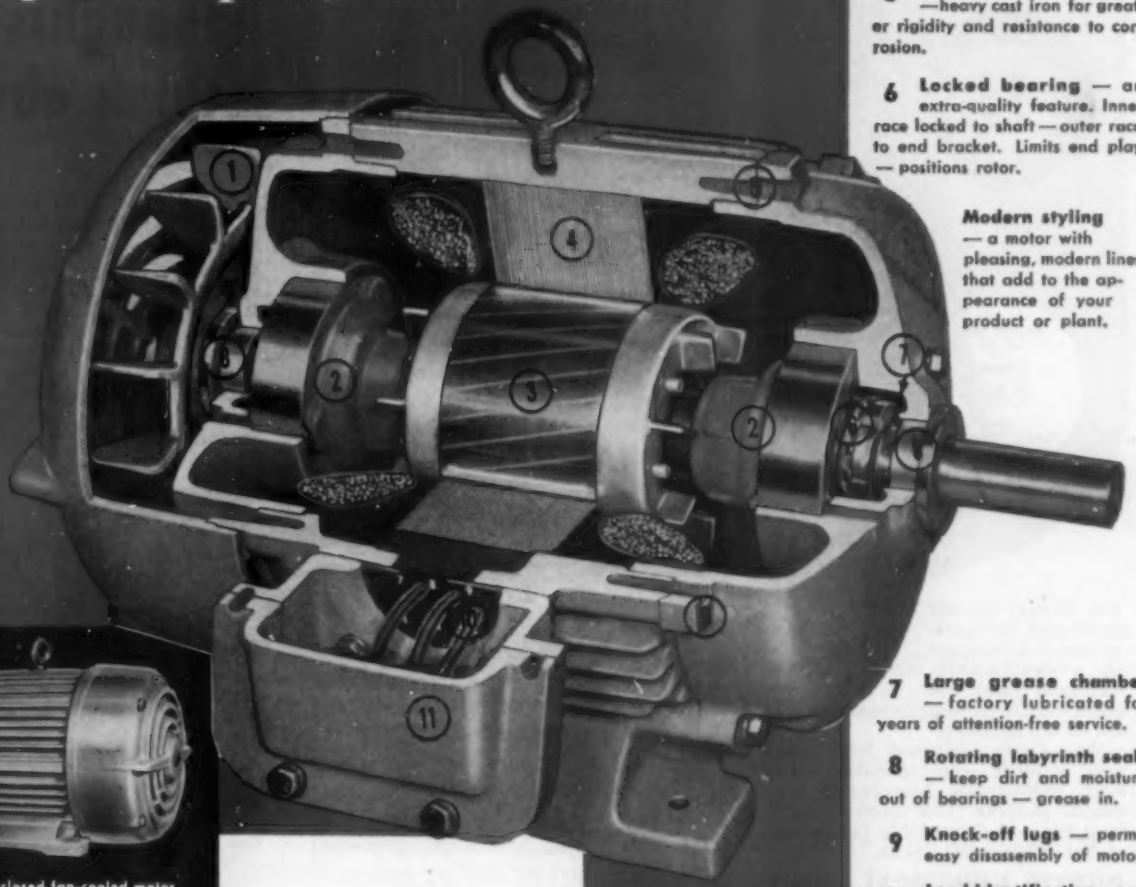
The forging of titanium parts also required heating. Since the forged parts generally are machined subsequent to forging, they may be heated to higher temperatures than those used for sheet metal forming. Normally, the forging temperature is approximately 1800 F and a hard skin forms on the parts as a result of contamination by the atmosphere. If this skin was not removed prior to welding, embrittlement of the weld head would result. In order to minimize the formation of this skin, heating in an inert atmosphere has been used, but is not required where sufficient skin removal follows forging.

The flow of the titanium under the drop hammer compares to stainless steel of the AISI 300 series. Filling of the dies is exceptionally good. It is

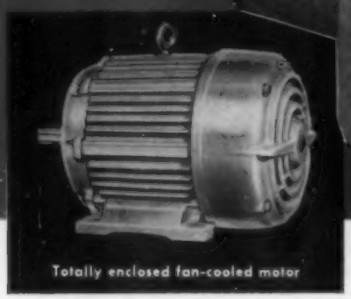
(Continued on page 398)

Here's the inside story of the NEW L.A. *Line*

...your BEST enclosed and explosion-proof motor BUY



Cutaway view of explosion-proof motor



Totally enclosed fan-cooled motor

1 Fan — efficient, non-sparking fan. New aerodynamic design for more effective cooling.

2 Inner bearing cartridges — lock bearings to end bracket and form explosion-quenching seal along shaft.

3 Indestructable cast-aluminum rotor—dynamically balanced with fan for smooth, quiet operation.

4 Stator — prewound stator core utilizes Formvar wire insulated with a new Alkyd Asphalt Resin insulating varnish.

5 End bracket and housing —heavy cast iron for greater rigidity and resistance to corrosion.

6 Locked bearing — an extra-quality feature. Inner race locked to shaft — outer race to end bracket. Limits end play — positions rotor.

Modern styling — a motor with pleasing, modern lines that add to the appearance of your product or plant.

7 Large grease chamber — factory lubricated for years of attention-free service.

8 Rotating labyrinth seals — keep dirt and moisture out of bearings — grease in.

9 Knock-off lugs — permit easy disassembly of motor.

10 Lead identification—permanent, positive lead identification spacer in conduit box.

11 New split conduit box — rugged cast-iron conduit box diagonally split for easy connection.

This is the completely new L.A. totally enclosed fan-cooled and explosion-proof motor. Every feature in this new line is designed for easier installation, longer service life, less maintenance and attention. You get the full benefit of the new NEMA standards in a smaller, more functional, completely modern design.

Your nearby Louis Allis Sales Engineer can show you all the reasons why these motors perform better and longer on your tough jobs — why they give you maximum resistance to corrosion wherever you need this extra protection. Call him today.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

LA-103

Vertical NEMA D-flange motor

NEMA C-flange motor

NEMA D-flange motor

We specialize in SPECIAL MOTORS — *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your toughest application. Whatever electrical or mechanical modifications you need, check first with Louis Allis.

Standard Quality sets Quality Standards

The day-in, day-out excellence, the quality which is standard in every Curtis Universal Joint, has made the Curtis Joint the quality standard of the industry.

Each Curtis Universal Joint component is made from specially selected steel, individually heat-treated for a specific purpose. This accounts for the long life and dependable performance of Curtis Universal Joints.

CURTIS UNIVERSAL JOINTS

- 14 sizes always in stock
- Fewer parts, simpler construction
- Complete equipment for government tests

Our catalog torque and load ratings are substantiated by constant tests. You can depend on them.

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE, SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

good practice to finish the forging in the lower temperature range of about 1450 F at the end of a series of hammer blows in order to achieve a finer grain size with its accompanying improvement in physical properties.

When spinning is applied to the forming of titanium, a departure from normal practice is necessary since titanium must be spun at an elevated temperature. In order to accomplish this heating, a group of manifolded oxygen-gas burners was set up above the spinning lathe.

A typical spinning was from a rolled conical section of 0.140 in. thick titanium on which the mating edges had been welded by means of an inert gas-shielded tungsten arc. The resulting cone was placed over the chuck and clamped with an end plate. The burners were then lit and positioned over the rotating cone. Spinning was performed manually by means of a hardened steel roller mounted on a scissor tool. When the temperature of the heated area reached the desired 1300 F, the spinning roller was applied by the operator to force the titanium into conformation with the chuck. The heating fires were kept aligned with the roller so that only the heated, and therefore ductile titanium was spun.

A basic consideration in the welding of titanium is the requirement that the molten metal be shielded from contact with air. Above 1500 F the titanium reacts with the oxygen and nitrogen of the atmosphere, becoming brittle and unworkable. In fusion welding, the argon or helium associated with the inert-arc welding process in conjunction with an auxiliary supply of gas provide the necessary protection. In resistance welding, the molten nugget at the joint interface is sufficiently protected by the parent metals that gas coverage is not required and the welds are made in air.

The spot, overlap spot and seam welding of the RC-A70 titanium was performed with no difficulty and with excellent results. Initial sample setups were made with those values of time, pressure, and current normally used for stainless steel, and when the parts were actually welded, only slight variations from these were required.

One outstanding feature of resistance welding on titanium is the tendency to excessive penetration of the

(Continued on page 400)

STEEL IS 2 TO 3 TIMES STRONGER THAN CAST IRON

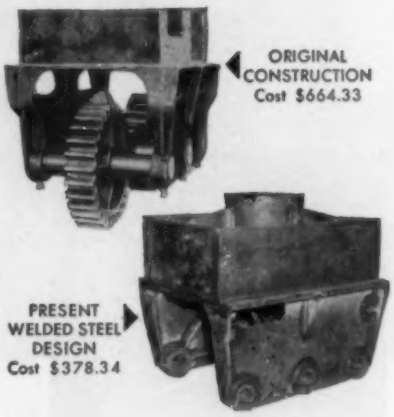
STEEL IS 2½ TIMES AS RIGID AS CAST IRON

STEEL COSTS ⅓ AS MUCH PER POUND AS CAST IRON

thoughts to think about

FIGURE the facts yourself. Only 40% as many pounds of metal are needed to build a machine part from steel as from cast iron. Furthermore, each pound of steel costs a third as much as iron. As a result, basic material costs using steel are about 15% of the costs using cast iron.

The large initial saving in material cost makes it possible to fabricate machine designs from steel at substantial reductions in cost.



Compare the two gear cases shown. The original cast construction cost $664.33. Changing to welded steel design has cut this cost to $378.34 . . . a 43% reduction in cost. In addition, scrap loss from metal defects has been entirely eliminated. Less material has to be left on for machining since distortion has been minimized.

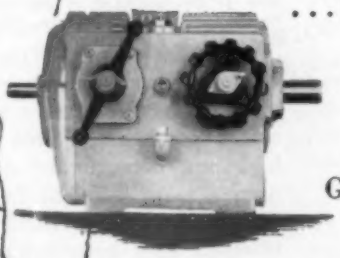
According to leading product engineers, low manufacturing costs are of prime importance today. Proper use of welded steel can enable you to achieve this objective on products you design. Write for further information.

THE LINCOLN ELECTRIC COMPANY

Dept. 1308
Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

Reversibility...WOW!



. . . the humming bird reverses its wings an estimated 4500 times a minute . . . effortlessly. We don't claim that our variable speed transmission can top the humming bird's accomplishment, BUT . . . for the record, we reversed a GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION (under load) over a million times — continuously, at a rate of 22 reversals per minute — without the slightest sign of wear.*

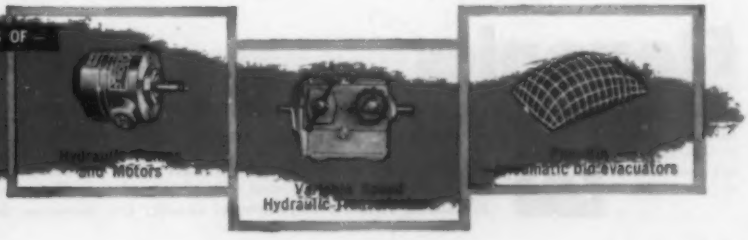
*. . . *doubt it?* Why not make us prove this and other outstanding features . . . send for literature TODAY.

MANUFACTURERS OF —

GEROTOR

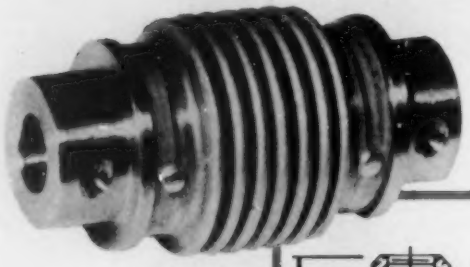
MAY CORPORATION

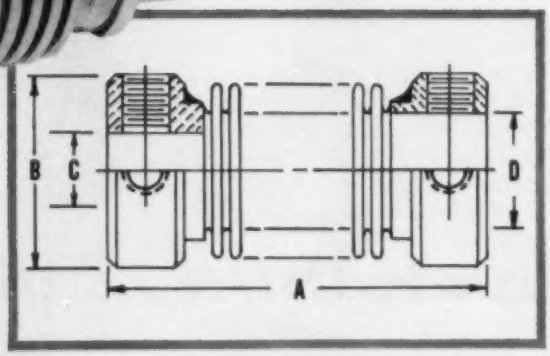
1511 MARYLAND AVENUE • BALTIMORE 3, MARYLAND



FLEXON BELLOWS *Design Briefs*

How to Select and Specify Flexon Bellows for Use in Low Torque Couplings





FLEXON OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel for vacuum equipment, thermostatic devices, pressure controls, packless valves, pneumatic instruments, hydraulic mechanisms, rotating shaft seals and many other services.

The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

Flexon Bellows offer the designer an economical means of coupling shafts when torque is low. The inherent flexibility of the bellows compensates for angularity and misalignment at a cost well below conventional methods.

However, because of the torque limitations certain basic considerations are necessary:

Allowable O.D. of bellows and/or shaft fittings
Allowable overall length including fittings
Maximum torque on bellows
Maximum misalignment
Frequency of rotary motion
Temperature range

With this data, Flexonics can develop bellows type couplings to fill a wide variety of needs, economically. Submit the data outlined above and Flexonics will design the bellows coupling to meet your requirements.

Flexonics *Corporation*

FLEXON BELLOWS DIVISION

1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS

—FORMERLY CHICAGO METAL HOSE CORPORATION—

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

weld nugget into the parent materials. This effect may be limited by proper welder setups to acceptable values. It is important when inspecting etched cross-sections of weld nuggets that differentiation be made between the actual dendritic cast metal of the nugget and the surrounding heat-affected zones. Casual examination will give an exaggerated impression of the penetration, since the structure of the heat-affected zones is somewhat similar in appearance to that of the nugget.

When seam or spotwelding dissimilar thicknesses, penetration into the thinner sheet titanium increased as the disparity in thicknesses increased. When welding a combination where the heavier metal was four times the thickness of the thinner sheet, penetration over the permissible 80 per cent was obtained. A practical working limit, therefore, for dissimilar metal xthickness may be taken as $(t_1/t_2) = 3$.

On the grades of titanium discussed no radical departure from stainless steel machining practices was required.

Variable-Speed Control For Integral Hp Motors

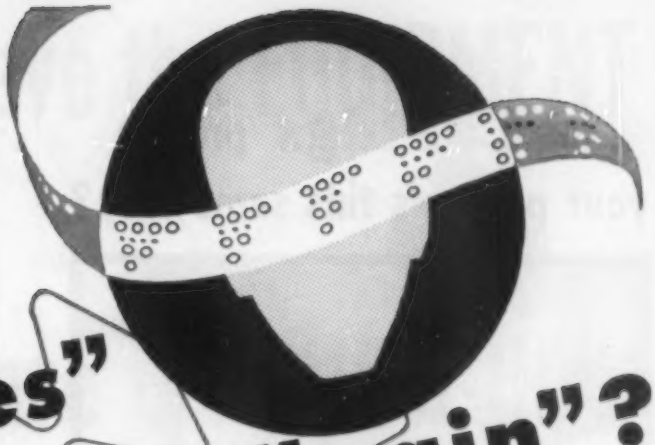
Abstracted from "Variable-Speed Control for Integral Hp Motors" by E. G. Cowie and J. H. Gregson, Canadian Westinghouse Co., Ltd., Hamilton, Ont. Canada: *Electronics*, April 1955.

Multifrequency-output power supplies are useful where a number of motor speeds are required such as in high-speed bore-grinding machines requiring many different fixed speeds. The equipment described here provides six fixed frequencies from 480 to 1660 cps available at four independent three-phase outlets. Line voltage is variable up to 300 v and 5 kva is available at each outlet to give required speed ranges of 20,000 to 100,000 rpm. The four channels obtained high-voltage plate supplies and control-circuit voltages from a common power-supply unit.

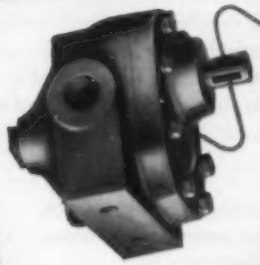
Frequency stability is better than 2 per cent and voltage regulation is approximately 5 per cent for motors operating between idling and full-load conditions.

The output of a Wien-bridge oscillator is fed into phase-splitting and voltage-regulating circuit. Three output voltages from this stage feed

Continued on page 403



need "muscles" for your "brain"?



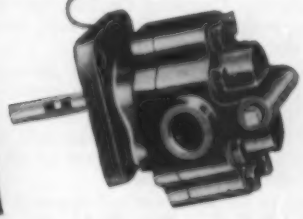
PESCO HYDRAULIC PUMPS

Gear-type Hydraulic Pumps are built with single or multiple elements in wide range of capacities for pressures up to 3000 psi. "Pressure Loaded" bearings for higher efficiency and longer service life. Can be furnished with Pesco Electric Motor as a Motor-Driven Hydraulic Pump; or with motor, reservoir and controls as a complete Pesco Power Package.

PESCO ELECTRIC MOTORS

Precision-built Pesco motors provide maximum power for minimum size and weight. Many types available for special needs; models with rigidly exact performance for servo applications.

Both DC and high frequency AC motors built in 5 coordinated frame sizes from 1/100 to 11 hp permitting use of standard parts to expedite design. Many superior features to meet any requirement on humidity, temperature, vibration, duty cycle or altitude.



PESCO HYDRAULIC MOTORS

Gear-type, positive displacement fluid motors to provide highly efficient, rotary, variable speed hydraulic power. Lightweight and compact, motors operate in either direction without mechanical adjustment. Starting torque efficiency is over 90%. Models available for operation at pressures to 1500 psi.

Does your electronic "brain" require hydraulic or electrical "muscles"?

To assure precise functioning of automatic devices, servo mechanisms, control equipment and instruments, equip them with *power by Pesco*—Hydraulic Pumps, Hydraulic Motors and Electric Motors. These aircraft-quality units operate with unmatched precision and absolute dependability over a long service life. They are extremely compact, lightweight and ruggedly built for severe environmental conditions.

For information on how these Pesco products can be applied to your particular problem, contact: PESCO, 24700 North Miles Rd., Bedford, Ohio.

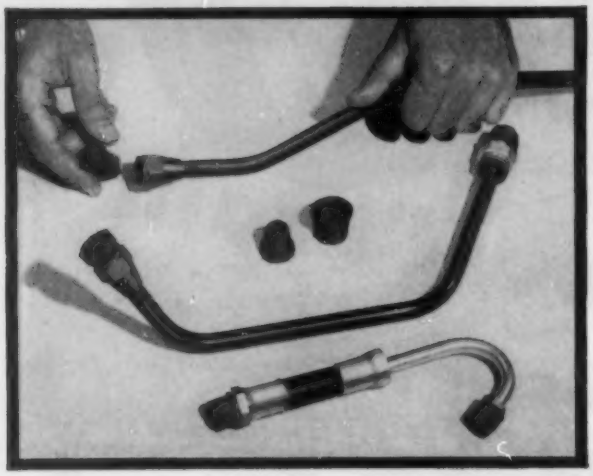
engineering Pesco production

PRODUCTS DIVISION

BORG-WARNER CORPORATION

24700 NORTH MILES ROAD • BEDFORD, OHIO

can CaPlugs protect your products this same way?



Look how Anchor Coupling Co., Inc. uses these tough, flexible closures to protect threads and seal assemblies from dirt during storage and shipment.

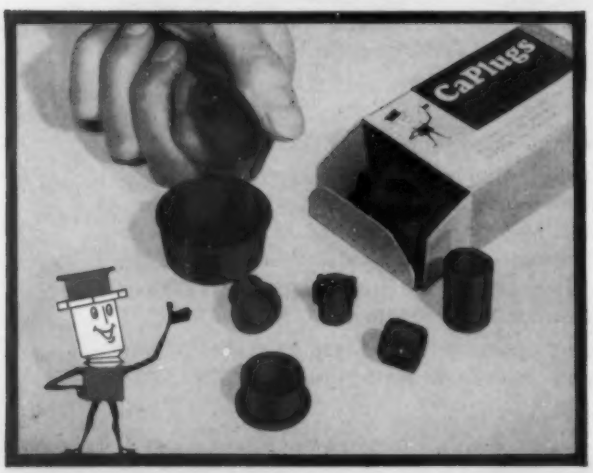
Says Anchor, "We are sure that assemblies will arrive in our customers' hands in the same clean condition as when they passed our final inspection."

Made of Polyethylene, CaPlugs will not collapse, chip, break or shred . . . are impervious to all common chemical reagents, acids and solvents.

Furnished in six standardized cap and plug designs (both threaded and non-threaded), CaPlugs are regularly used by hundreds of industries on numerous types of tubing, valves, hydraulic components, fittings and machined parts.

Stocked in over 200 sizes (up to 8" in dia.), CaPlugs are readily obtainable to protect your products profitably, too!

find out by writing for this FREE assortment



CaPlugs

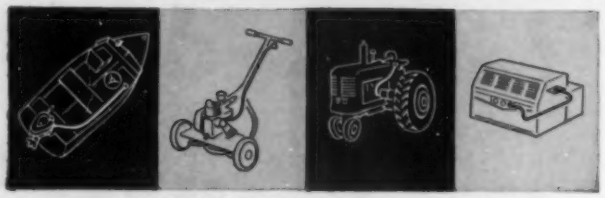
DIVISION

PROTECTIVE CLOSURES CO., INC.

2205-9 ELMWOOD AVE. BUFFALO 23, N. Y.

LOW COST • EASY TO INSTALL

PUSH-PULL REMOTE CONTROLS...



You'll find that Arens Push-Pull controls offer the simple and low cost answer to control operation of light to heavy load action over long or short distances.

Standard Arens Controls for most applications are available with a variety of control heads, casings and end fittings. Special controls can also be designed to meet specific requirements.

Write For Complete Information and 42-page illustrated remote control catalog.

ARENS CONTROLS, INC.

2013 Greenleaf Street, Evanston, Illinois

PORCELAIN PRODUCTS, INC. Announces

★

Custom molding

Fiberglas reinforced

Polyester

Now, let over 60 years of electrical porcelain experience provide you *better* design, *better* construction . . . a *better* product . . . for your Fiberglas reinforced polyester requirements.

Porcelain Products offers:

- Competent engineering staff to assist in proper design.
- Compression molding of Porcelain's own compounded material to meet *your* specific requirements.
- Molds designed and produced in our own machine shop.

Write today, to 80 West Sandusky St.

61 Years — Porcelain Products, Inc. — PP INC.

FINDLAY, OHIO

three identical amplifiers consisting of a 6Fy class-A preamplifier, class-AB_2 push-pull 807 driver and class-B push-pull 833A output stage. Secondaries of the output transformers are connected in delta for three-phase output. Taps permit load matching.

One of six frequencies may be obtained from the oscillator by switching in the Wein-bridge circuit; this switch also adjusts voltage-equalizing and phase-shift circuits so that a minimum of additional adjustment is required. The output voltage is adjusted to the desired level by the potentiometer in the input circuit of the regulator stage. The first half of a 6SN7 is the voltage regulator and the second is the phase-splitting circuit.

The regulator circuit relies on 6SN7 characteristics and is similar in operation to the avc circuit used in radio receivers. The tube is normally self-biased at the high-gain portion of the characteristic curve for zero-signal operation. The control bias, derived from the output voltage, is adjusted by negative feedback so that the stage gain is inversely proportional to the output voltage. Input to this stage is adjusted to give the desired voltage at the motor terminals. Output-voltage fluctuations caused by load variations are almost completely compensated for by this circuit.

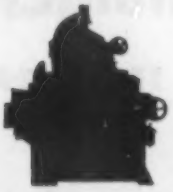
Phase shifts required to supply three-phase are obtained by an LCR network in phase-splitting circuit.

Since the full-load demand approaches rated output of the high-frequency channel, across-the-line starting is not possible, for the demand on the channel would then exceed capacity. Reduced-voltage starting is obtained by applying the filament voltage to the 6SN7 while full a-c drive voltage is applied to the grid. Since this tube supplies voltage for all three phases, the three-phase voltages are equal throughout the starting cycle.

Rate of rise of output voltages can be matched to the speed of the largest motor by inserting resistors in series with the filament of the 6SN7; the filament circuit is eneregized when the motor start button is pressed. Resistances in series with the motor reduces inrush currents, provide a better impedance match between output tubes and load, and also limit any negative-sequence current which may

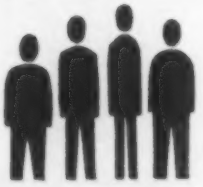
Continued on page 404

We have the EQUIPMENT

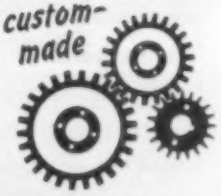


We have the KNOW-HOW

We have the CRAFTSMEN



to satisfy ALL OF YOUR



GEAR REQUIREMENTS!

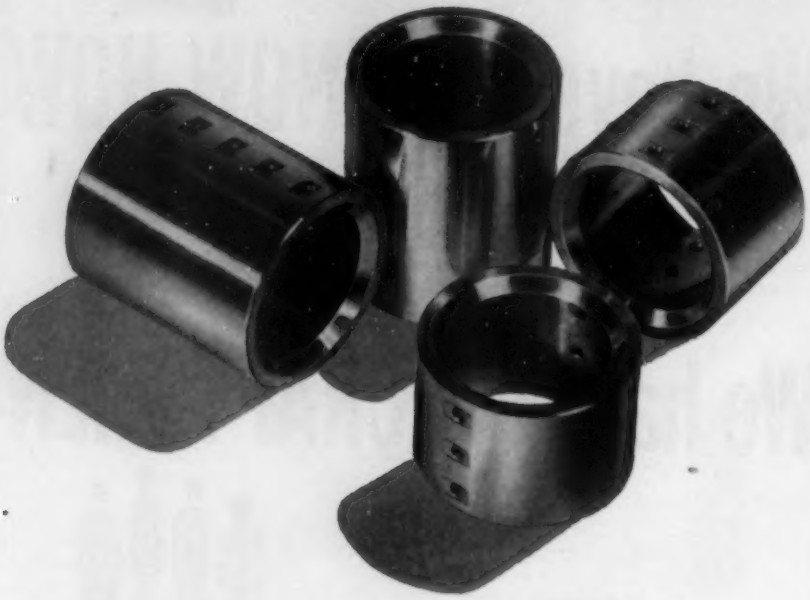
PERKINS MAKES:
to customers' specifications, in all materials, metallic and non-metallic: bevel gears, ratchets, sprockets, ground thread worms, spiral gears, helical gears, spur gears with shaved or ground teeth.

NOTE: The PERKINS PRECISION SPRING COILER is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want when you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire sizes .005 to .125. Diameter, from 3/32" to 12" and larger. Size of the compact coiler is only 7 1/2x16". A POWER MODEL is available. Information on request.

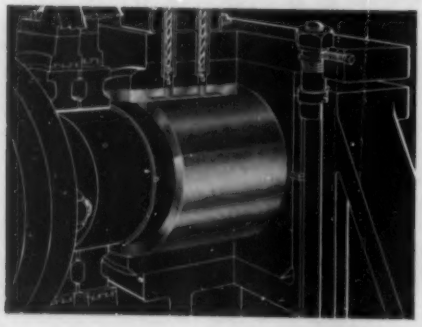
PERKINS MACHINE & GEAR CO.
105 Circuit Ave., WEST SPRINGFIELD, MASSACHUSETTS

Consider your customer...

IN BEARING SPECIFICATIONS



Disassembly and removal of the original bearing and reassembly with a new bearing are inevitable at some time or other in the life of every machine. The frequency and cost of such service is a big consideration in the mind of your customer. The cast Bunting Bronze Bearing gives you maximum of bearing performance and life with far less costly and laborious replacement than any other type of bearing.



Designs like this present no production nor replacement complications. Bunting engineers will gladly collaborate with you in a study of your bearing requirements. There is a Bunting engineer near you, or write our Products Engineering Department at Toledo.

Bunting®

BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS

THE BUNTING BRASS AND BRONZE COMPANY, TOLEDO 1, OHIO
BRANCHES IN PRINCIPAL CITIES • DISTRIBUTORS EVERYWHERE

be generated on starting the motor. This resistance is shorted out when the motor reaches synchronous speed. Sufficient capacitance is connected in parallel with each motor to give unity power factor at full load.

The equipment operates from a 440-v, 60-1 cps, three-phase line. The line voltage is converted to 4,000 and 600 v, dc, for the power-output and driver stages of the high-frequency channels and to 115 v, ac, for blowers, filament transformers and control circuits. Power transformers are connected three-phase double-Y, which results in a 360-cps ripple on dc. Since the driver and output stages are push-pull, no d-c filtering is necessary.

Application of Germanium Power Rectifiers

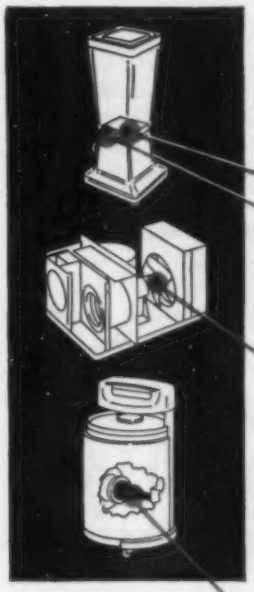
Abstracted from "Application of Germanium Power Rectifiers",, by R. M. Crenshaw, General Electric Co., San Francisco, Calif; *Electrical Engineering*, May, 1955.

For many years copper oxide and selenium rectifiers have been important where d-c power is needed in moderate quantities for industrial plants. Now the germanium power rectifier promises to replace them in many applications. A very small quantity of the metal will perform a large rectifying job. The material is sliced into wafers 0.02 in. thick and the diameter of a dime. Small size is an advantage.

The ratio of forward to reverse resistance is in the order of 1 : 400,000 at the area of optimum rating including that of other metallic rectifiers. Small size is advantageous only if the material can be worked at high current density. The germanium cell operates at a current density almost 1,000 times greater than copper oxide. One of the dime-sized germanium wafers, when properly cooled, can rectify as much as 3 kw. The small size offers problems in the physical connections which handle relatively large currents, and in effectively removing heat.

Like other metallic rectifiers, germanium has a negative temperature characteristic. Forward losses are a function of load current and reverse losses are a function of inverse voltage. Both losses cause a temperature rise which changes cell resistance to further modify the losses. Because reverse-current change is exponential, reverse losses increase rapidly as tem-

(Continued on page 406)



LORD FACTS ON VIBRATION . . .

YOUR PRODUCT NEEDS "silent salesmen"

Solve your vibration and shock problems in the design stage, and you will give your product the advantages of "SILENT SALESMEN" for better performance and greater customer acceptance.

LORD Bonded-Rubber Mountings have gained wide acceptance for effectively reducing vibration and shock forces on all types of products. You will discover new design and performance advantages made possible through the use of these outstanding units. LORD has the experience and know-how to serve you best in this important field.

Equally important are the *SERVICES* and *SKILLS* available to you at LORD . . . ready to tackle your vibration problems. Experienced engineers and skilled workmen form the team that will help to improve the sales appeal of your product.

Your local LORD Field Engineer is as near as your telephone. Call or write the home office, Erie, Pa.

LORD MANUFACTURING COMPANY • ERIE, PENNSYLVANIA

LOS ANGELES, CAL. HOllywood 4-7593	DALLAS, TEXAS RIverside 3392	DETROIT, MICH. TRinity 4-2060	NEW YORK, N. Y. Circle 7-3326
PHILADELPHIA, PENNA. LOcust 4-0147	DAYTON, OHIO MIchigan 8871	CHICAGO, ILL. MIchigan 2-6010	CLEVELAND, OHIO SUperior 1-3242

LORD BONDED RUBBER

DESIGNERS AND PRODUCERS OF BONDED RUBBER PRODUCTS SINCE 1924

ARE WE IN YOUR FILES?

AS A DEPENDABLE SOURCE FOR
MAGNESIUM PARTS AND PRODUCTS

Whether you plan the development of a new product, or are seeking ways to further improve existing ones, you will be interested in the many new avenues which are open to the design engineer who includes magnesium in his basic planning.

Magline Inc.—one of America's leaders in magnesium—has prepared a descriptive new bulletin, expressly outlining for designers and engineers, the company's services as a reliable, experienced source for magnesium castings, fabrication and complete production. Specialists in magnesium exclusively, Magline's background and experience will serve you well in three important ways: (1) Objectively searching out ways to improve your product through the application of magnesium; (2) Assisting in the design and development phases; (3) Producing the required parts and components in any quantity, to your exact specifications. May we send you a copy of Bulletin No. 50.

MagLine

fabrication facilities for
- Forming
- Machining
- Welding
- Stamping
- Spinning
- Deep Drawing
- Polishing
- Finishing
- Stress Relieving
- Assembly
- Impact Extruding

foundry facilities for
- Sand Castings
- Die Castings
- Permanent Molds

Design and Engineering Services Available

WRITE TODAY FOR BULLETIN NO. 50. MAGLINE, INC., BOX 2311, PINCONNING, MICHIGAN.
CANADIAN FACTORY: MAGLINE OF CANADA, LIMITED, RENFREW, ONTARIO.

perature rises. The heat must be dissipated from the small cell area rapidly and radiating fins with forced air or liquid immersion have proved the most effective. The normal full-load temperature rise of a cell is 30 C over a 35 C ambient. The cell is derated for higher ambient temperatures. The derating can be by current or voltage.

Germanium rectifier cells can be connected for single-way or double-way, single-phase and three-phase operation; and individual cells can be operated at a voltage considerably higher than is customary with other metallic rectifiers of equivalent rating. For example, a standard two-way, three-phase rectifier connection using six individual cells has a rating of 225 amp at 65 v, dc. Such a self-contained power supply can be connected, on the d-c output side, in series or parallel with other equivalent units to form most combinations and ratings.

Squirrel-Cage Motors and High Inertia Loads

Abstracted from "Squirrel-Cage Motors and High Inertia Loads" by G. Byberg, Motor and Generator Section, Allis-Chalmers Mfg. Co.; *Allis-Chalmers Electrical Review*, First Quarter, 1955.

When applying large squirrel-cage motors to high inertia loads, it is often difficult to determine whether a motor will have sufficient thermal capacity to dissipate energy losses while bringing the load up to speed. High load Wk^2 of fans, blowers, and other machines used for impelling low density materials usually require a longer-than-normal time for acceleration.

The time required to accelerate a given drive is:

$$t = \frac{Wk^2 \times rpm}{307.5 \times T_a}$$

where t = time in seconds.

Wk^2 = combined inertia of the driven machine and the motor in lb-ft².

If load speed is different than motor speed, equivalent load Wk^2 at the motor shaft is: (load speed/motor speed)² × load Wk^2.

T_a = motor torque less torque required by load on driven machine, in lb-ft².

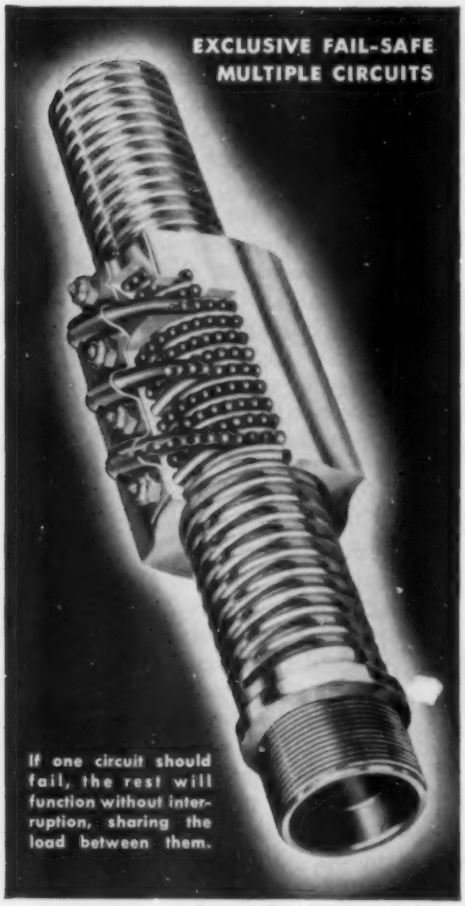
Rpm = motor speed at full load

Starting time for a given horsepower input, depends upon the load Wk^2

(Continued on page 408)

Now—

UNPRECEDENTED BENEFITS FOR ALL YOUR ACTUATOR APPLICATIONS WITH THE SAGINAW BALL/BEARING SCREW


EXCLUSIVE FAIL-SAFE MULTIPLE CIRCUITS
If one circuit should fail, the rest will function without interruption, sharing the load between them.

SPACE/WEIGHT SAVINGS PERMIT MORE PAYLOAD

Compared to either Acme screw or hydraulic actuators, the *Safety b/b Screw* saves significant weight and space by permitting the use of smaller motors and gear boxes; eliminating pumps, accumulators, piping, etc.

DEPENDABLE OPERATION DESPITE LACK OF LUBE

Because the *Safety b/b Screw* is inherently so friction-free (operating at 90% to 95% efficiency), it will function with only a small loss of efficiency *even if lubrication fails or cannot originally be provided.*

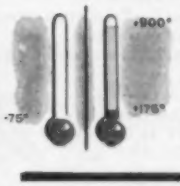
FAR LESS DRAIN ON ELECTRICAL SYSTEM

By requiring only 1/3 as much torque as a conventional Acme screw for the same amount of lineal output, the *Safety b/b Screw* allows the use of much smaller motors which save a substantial amount of power.

POSITIVE POSITIONING AND SYNCHRONIZATION

Unlike some other types of actuators, the *Safety b/b Screw* permits precision control within thousandths of an inch, plus perfect synchronization of two or more movements—a tremendous aircraft advantage.

RELIABLE PERFORMANCE AT EXTREME TEMPERATURES



Exhaustive laboratory tests prove that the *Safety b/b Screw* operates dependably at both extremely low and high temperatures, ranging from—75° F to + 175° F, and up to + 900° F with special consideration.

GREATLY DECREASED COMBAT VULNERABILITY

By eliminating highly vulnerable hydraulic lines, accumulators, etc., the *Safety b/b Screw* makes military aircraft actuation far more dependable. It also reduces maintenance, due to decreased dirt sensitivity.

UNITS HAVE BEEN PRODUCED FROM 1½ IN. TO 39½ FT.

SEND TODAY FOR YOUR FREE ENGINEERING DATA BOOK

(or see our section in Sweet's Product Design File).

Saginaw Steering Gear Div.,
General Motors Corp.
Dept. 0J Saginaw, Michigan

Please send your Engineering Data Book to:

Name—Title_____

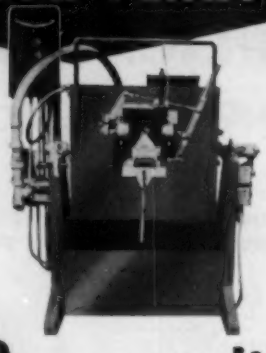
Firm_____

Address_____

City_____ Zone____ State_____

Safety ball/bearing Screw by Saginaw

DO YOUR OWN
AUTOMATION AUTOMATION
METAL CASTINGS
AUTOMATION AUTOMATION
IN YOUR PLANT



with the Grav-o-matic™
AUTOMATIC GRAVITY CASTING MACHINE
U.S. Pat. Nos. 2,411,176 2,429,145 2,429,146 2,474,963 (Wessel Process)

ADVANTAGES

Quality of Castings

The quality of castings is *superior* because of higher tensile strength plus a grain structure equivalent to a forging.

Cost Savings

Automatic temperature, pouring control and casting cycle *eliminates the necessity for skilled labor* . . . Production rates are from 20% to 30% higher than other methods . . . closer dimensional tolerance reduces subsequent machining.

Installation and Operation

The extreme simplicity of design requires practically no maintenance and a working space of as little as 100 sq. ft.

Molds

Complete design, engineering and manufacturing services, including sample castings, are available at low cost.

NOW AVAILABLE FOR LEASE

The Grav-o-matic is available for lease from $200 per month . . . instruction of operator included.

SEND FOR FULL INFORMATION

SALES REPRESENTATIVES INQUIRIES INVITED

Grav-o-matic A PRODUCT OF AUTOMATION · ENGINEERING CORPORATION
Dept. D-1, 1127 Wilshire Blvd.,
Los Angeles 17, Calif.

of the driven machine. Using full-voltage starting, starting time may be as low as 3 to 5 sec for a driven machine with low Wk^2. High inertia drives, such as fans, blowers, and compressors, may require 40 sec or more to accelerate to full speed.

A starting time of 15 to 20 sec is usually normal for standard cage motors. Most applications in which starting time exceeds 20 sec and all over 30 sec require special motors.

For high inertia loads the shorter starting time of high torque motors reduces stator heating, since the stator winding carries starting current for a shorter time. However, heating of the cage winding due to acceleration of load inertia is not reduced. The energy which must be absorbed by and dissipated from the cage winding because of load inertia acceleration equals the kinetic energy stored in the rotating parts at full speed and is independent of time. A shorter starting time helps only in reducing cage winding losses due to the load.

To simplify the problem of applying standard squirrel-cage motors rated 200 hp and larger to marginal high inertia loads, NEMA standards indicate the maximum load Wk^2 of machines to which standard cage motors can be applied. These values are based on experience and practice, and are based on following conditions:

First, they are based on motors having normal-torque characteristics and a full load temperature rise of 40 C by thermometer. Higher rated temperatures generally will mean reduced load Wk^2 values; for example, a 100 C rise silicone-insulated motor may use the next or second smaller 40 C rise frame, with a consequent reduction in winding thermal capacity.

Second, these values are based on a load-torque requirement varying as the square of the speed. Should the load torque exceed this, torque available for load Wk^2 acceleration decreases.

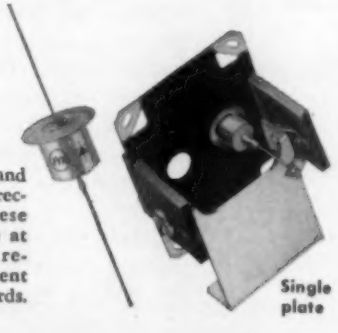
Third, number of successive starts is limited. If in, addition to accelerating high inertia and providing the load torque, a motor is subject to repeated starts without sufficient time to allow the motor to return to or near rated normal operating temperatures, the heating effect is cumulative and can prove destructive. Where both load Wk^2 and the number of successive starts is excessive, even a cage motor nears edge of reliability.

Federal's new germanium rectifier stacks—

a mighty handful of DC power!

Smallest, lightest, most rigid... rated up to 565 volts DC and up to 6 amps...1 to 12 fins

(Over 100 standardized combinations)



Single plate

The 1N91, 1N92, and 1N93 germanium rectifiers used in these new stacks assure at least 20% lower reverse leakage current than RETMA standards.

Once in a while a new design is so good that it sets entirely new standards for an electronic component. The *new* Federal germanium stacks are like that. Here are seven of their most important advantages over existing types . . . advantages that mean a *better* rectifier for *your* equipment:

- **SPACE-SAVING** —The stacks average one-third shorter in length.
- **LIGHTWEIGHT** —Light, strong plastic side strips are used instead of heavy axial assembly bolts and insulators.
- **RIGID CONSTRUCTION** —Interlocking of fins and strips builds a "tight" structure unaffected by vibration.
- **BETTER HEAT DISSIPATION** —Full area of the fin is available for cooling.
- **TERMINAL LUGS ELIMINATED** —Terminals are stamped out as part of the fin corners, so that wires may be soldered directly to the fin.
- **NO PROTRUDING BUS BARS** —Corners of fins are clipped out for passage of bus bars connecting non-adjacent plates.
- **FULLY INTERCHANGEABLE** —Electrically and mechanically interchangeable with types now on the market.

For detailed information, ask for "Federal Germanium Power Stacks" booklet. Phone NUtley 2-3600 or write to Dept. F-242.

Federal

A DIVISION OF I T & T

FTR · FEDERAL TELEPHONE & RADIO

Federal Telephone and Radio Company

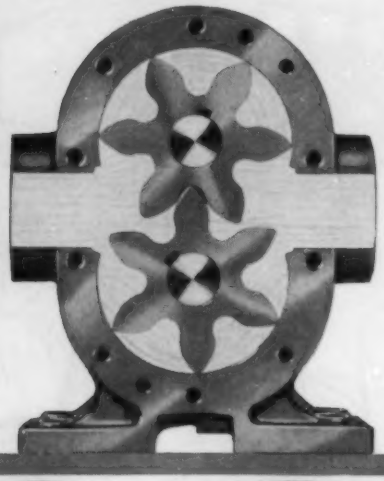
A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

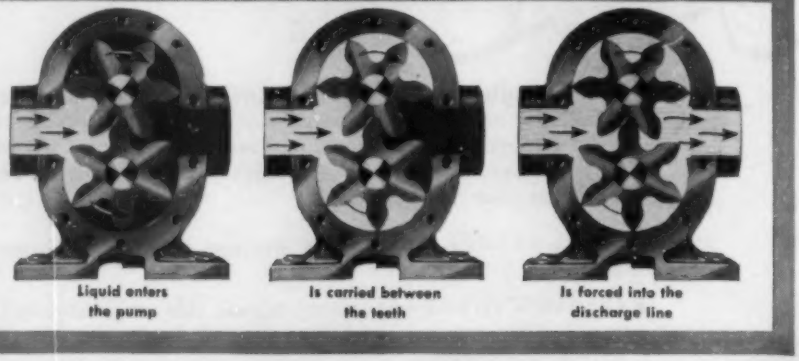
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

IF
"THE PRINCIPLE OF THE THING"
MEANS ANYTHING TO YOU
then look to ROPER

only 2 moving parts
HELP MAKE ROPERS DEPENDABLE





SMOOTH AND QUIET FLOW...
EQUAL EFFICIENCY IN EITHER DIRECTION

HOW IT OPERATES — The unmeshing of the gears produces a vacuum, drawing the liquid into the tooth spaces. The liquid is carried between the teeth and case to the opposite side of the pump. The meshing of the gears forces the liquid into the discharge line. This is a positive displacement pump. The Roper principle is simple in design. It has only two moving parts — equal size pumping gears — operating in a case with proper amount of clearance to promote high efficiency and long life.

GEO. D. ROPER CORPORATION 381 Blackhawk Park Ave., Rockford, Ill.

Send for helpful handbook
"HOW TO SOLVE PUMPING PROBLEMS"

ROPER Rotary Pumps

NEW BOOKS

Mathematics of Engineering Systems

DEREK F. LAWDEN, *M.A., Sr. Lecturer in Math., College of Technology, Birmingham, England.* 8¾ x 5¾ *in., 380 pp. Published by John Wiley and Sons, 440 Fourth Ave., New York, N. Y.* $5.75.

This book presents a number of mathematical methods which can be used to analyze the behavior of a large number of physical dynamic systems such as electronic amplifiers and oscillators, electric circuits, servomechanisms and regulators, the behavior of which can be expressed approximately in mathematical form.

Since the book is a mathematical text, the emphasis has been placed throughout on the mathematical methods being described, rather than the engineering problems being solved. However, no mathematical method has been treated entirely in the abstract, but each is used to solve a number of practical problems. Many other examples of the use of the method are suggested to the reader in the sets of exercises included.

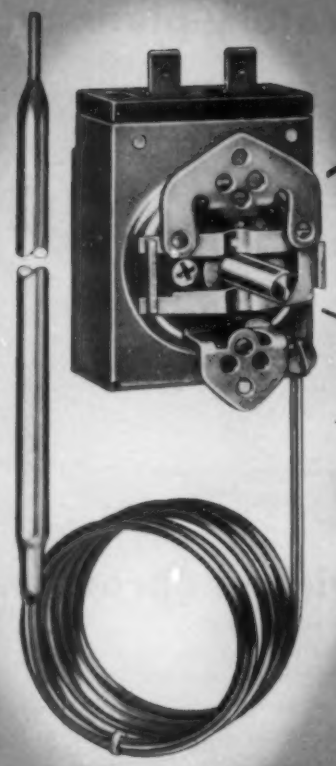
The various methods of mathematical analysis have been gathered together and developed in logical sequence to form a modern course of applied math. They provide a link between the conventional calculus textbook and the theory of functions of a complex variable used in the mathematical analysis of dynamic systems.

Linear differential equations with constant coefficients are treated in one chapter using classical methods of solution, and in another using modern methods including response of linear systems to unit step functions and to standard sinusoidal inputs. The Fourier analysis is expanded at length and nonlinear differential equations are treated in detail.

Development of solutions, practical application examples, and associated drawings and diagrams have been

(Continued on page 413)

NEW LOW-COST THERMOSTAT suitable for wide range of uses



The new EA type thermostats available for temperatures from 60° to 550° F. and for use with air or liquids.

- Clothes Dryers
- Air Conditioners
- Deep Fat Fryers
- Culture Ovens
- Egg Washers

- Electric Roasters
- Home Pasteurizers
- Laboratory Equipment
- Hospital Sterilizers
- Electric Ovens

- Oil Burners
- Motor Controls
- Livestock Watering Tanks
- Poultry Brooders
- Space Heaters

The new Robertshaw EA thermostats are designed to fill the need for a low-cost precision control requiring rapid response to extremely close temperature differentials.

It can be supplied with bulbs suitable for operation in liquid or air. Model EA thermostats are of snap-action, single line and double break design. Silver contacts and stainless steel bellows are designed for durability and sustained accuracy in service. The same power element is incorporated which is used in tho heavy-duty Robertshaw controls.

For more detailed information about the EA type of thermostats or other types which we manufacture, write us describing the nature of your specific problem.

Mr. Controls

Robertshaw-Fulton
CONTROLS COMPANY

Robertshaw Thermostat Division
Youngwood, Pennsylvania
Robertshaw-Fulton Controls (Canada) Ltd., Toronto

Aeronautical Division, Anaheim, Cal. • American Controls Division, St. Louis, Mo. • Bridgeport Thermostat Division, Milford, Conn. • Fielden Instrument Division, Philadelphia, Pa. • Fulton Sylphon Division, Knoxville, Tenn. • Grayson Controls Division, Long Beach, Cal. • Robertshaw Thermostat Division, Youngwood, Pa.

Select the control that helps you sell.

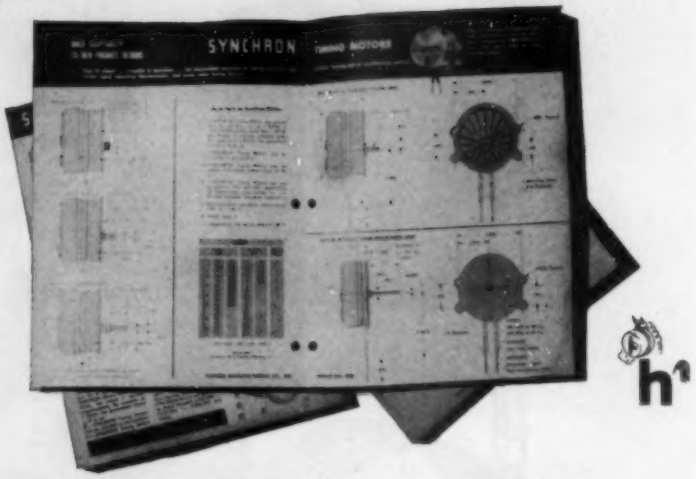
Robertshaw-Fulton Controls Company PF
Greensburg, Pennsylvania

Gentlemen:
Please send detailed information on your type EA thermostat. I am interested in application for

_____

NAME.....
COMPANY.....
ADDRESS.....
CITY..... STATE.....

exploratory planning . . .



can often mean tremendous savings in production

SUCCESS OR FAILURE of your new product or timing device may well depend upon cost of production. It may be sound in principle and design . . . may meet a specific need . . . but if it costs too much to make, out the window it goes.

Often a slight change in motor application or gearing will enable you to trim manufacturing costs to a practical and profitable figure. It is here that Synchron engineers can help materially. Just tell us what is expected of our motors* . . . the general nature of the job the mechanism is to do, performance characteristics, and the proposed method of mounting. Send along a sketch if possible.

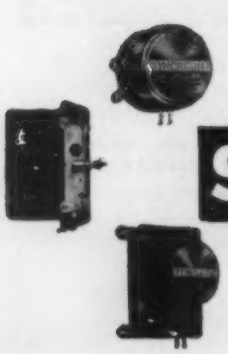
Our engineers will submit their suggestions and a sample motor . . . assistance which may save you many costly hours of research and testing. This service is strictly confidential, and available without obligation to established, rated organizations.

Get in touch with your SYNCHRON representative or write direct to the factory. You will receive prompt, efficient and courteous attention.

FACTORY REPRESENTATIVES:

Wesley & Fromm, 5254 W. Madison St., Chicago, Ill.
R. H. Winslow & Associates, 123 E. 37th St., New York, N. Y.
Electric Motor Engineering, Inc., 8255 Beverly Blvd., Los Angeles, Cal.
Cable-Hight Co., 1900 Euclid Ave., Cleveland 15, Ohio
Lawrence Sales Co., P. O. Box 13026, Dallas, Texas

*SYNCHRON synchronous motors operate smoothly and quietly in any position, at temperatures from —40° to +140° F. . . . start instantly under load . . . pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.



"Workhorse of the Industry"

SYNCHRON SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, AND MAGNA-TORC D.C. MOTORS

HANSEN MANUFACTURING CO., INC. PRINCETON 5, INDIANA

Established 1907

GET THE METALWORKING FACT YOU WANT
WHEN YOU WANT IT...

That's what you now get, 100%
in this new handbook

Here's outstanding news for all concerned with metalworking in its technical planning and production stages. Now you can have a famous reference book, of long-standing reputation, in entirely modernized form.

Now, THE NEW AMERICAN MACHINIST'S HANDBOOK brings you today's practice--today's needed data--in profusion. In it you will find 1579 pages of dependable facts to speed up and simplify your work in shop and drafting room.

← See the news inside

Here's the news about

THE BIGGEST IMPROVEMENT
IN NEARLY 50 YEARS
...a brand new working tool for you

--80% REWRITTEN

--REARRANGED TO CONTAIN MORE FACTS...GIVE QUICKER REFERENCE

--HUNDREDS AND HUNDREDS OF NEW FACTS...FIGURES... IDEAS...METHODS

Through nearly 5 decades, the American Machinists' Handbook has appeared in 8 editions. Each one was an improved version of the previous one. Altogether they sold hundreds of thousands of copies. Now, a greater-than-ever improvement in the book has been necessary. A huge number of new facts had to be added. Considerable rearrangement was needed, to allow space for much more information and to give easier, quicker reference. With all this, the Handbook had to be published as an entirely new book.

The facts behind this monumental change

Preface

No handbook serving metalworking can be considered up to date unless it has been completely rewritten and revised since 1950.

This is true because of the exceptionally rapid advancement since the last war in the methods for machining, forming, and joining of metals; the improvement in cutting materials; the new constructional steels and tool steels; and the refinements in heat-treatment and finishing. Further, there have been many important developments in gearing, splines, threads, fastening devices, drafting practice, machine-tool components, and power-transmission equipment. In short, the technology, standards, and practices of metalworking have grown and broadened in keeping with the industry's expansion to the number 1 position in the American economy.

These considerations led to the development of "The New American Machinist's Handbook," as successor to that great work, "The American Machinists' Handbook," or "

"I answer your machine shop questions"

Suppose a man could carry thousands of facts in mind and recall them instantly and accurately. Suppose he could describe machines, tools, and miscellaneous equipment—give the facts needed to work with them—advise you as to the preferred methods of scores of leading shops—draw schematic diagrams for you—help you estimate production time and choose feeds, speeds, or pressures—give you details or data on parts, materials, fits, etc., on hundreds of items.

In short, suppose someone came along and offered you such a complete service as this—how much do you think it would cost? Provided any such walking encyclopedia could be found, how much do you think it would cost to retain his services, so that you could get answers to your questions immediately, as problems came up, day by day, week by week, month by month, *without delaying work?*

The cost probably would be prohibitive—*yet the practical equivalent of such service is available.* You'll find everything outlined above, and more, in The New American Machinist's Handbook. Here *is* your "answer man"—carrying a wealth of the most vital and wanted machine shop information—drawn from authoritative sources—classified and presented for easy use. And you can take it into your shop—have it complete and always ready for use—at low cost.

The NEW American Machinist's HANDBOOK

***Edited by* RUPERT LE GRAND**

Senior Associate Editor, *American Machinist*

Based upon earlier editions of American Machinists' Handbook edited by Fred H. Colvin and Frank A. Stanley

1579 pages, 5⅜ x 8, 774 illustrations

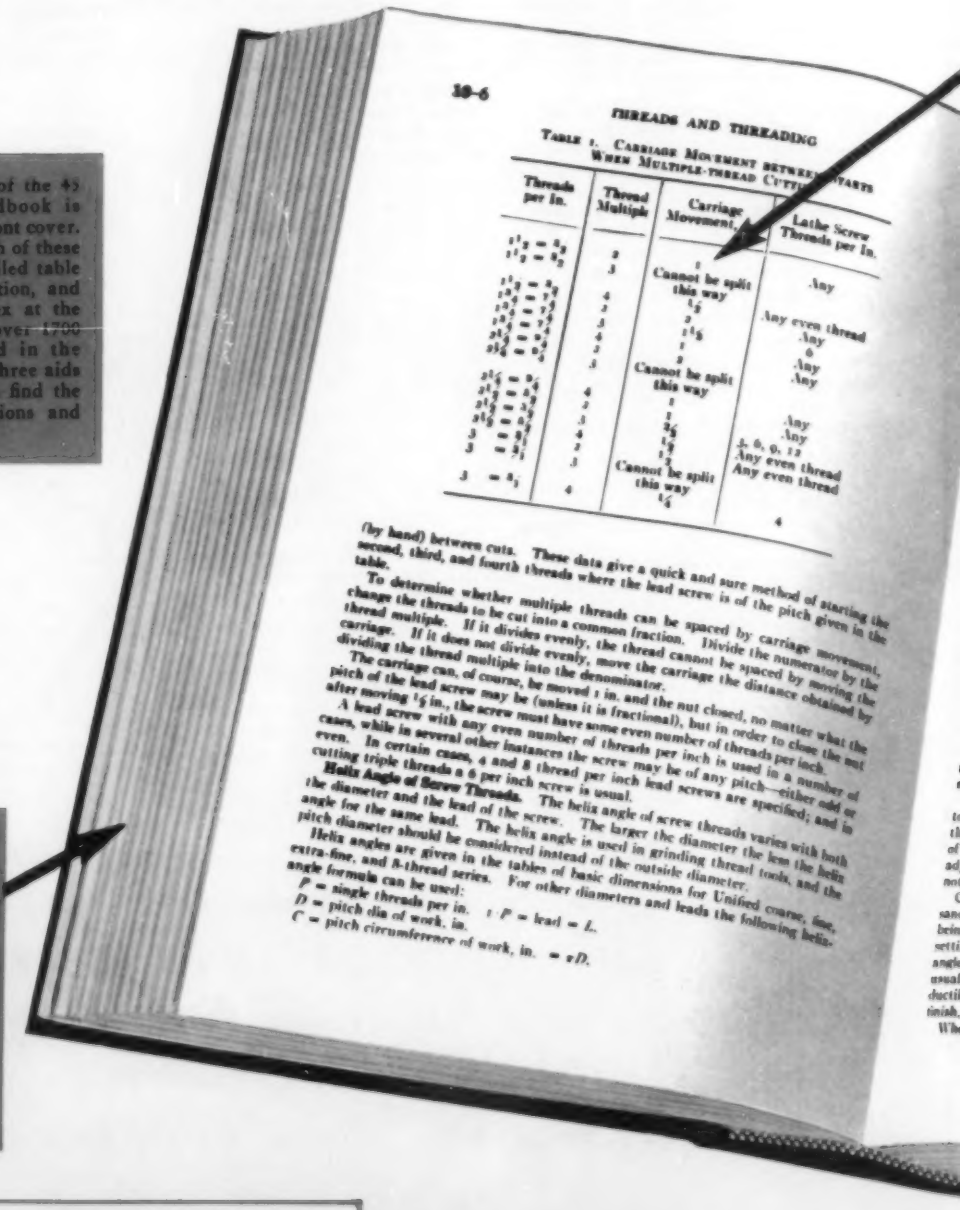
$11.00, payable $3 in 10 days and $2 monthly

COMPLETE CONTENTS INSIDE

Use The NEW American Machi

Here is an outstanding and helpful authority for every shop man who wants to get the most out of his own time, equipment, and material, or the men he supervises. In small contract shops, in gigantic plants, thousands of copies of earlier editions are aiding shop executives, engineers, tool designers, draftsmen, master mechanics, operators, and apprentices, to get better results at lower cost. Now, in its completely reorganized and improved form, *The New American Machinist's Handbook* more than ever warrants being called the "bible" of metalworking, machinery manufacturing, and allied industries. The less-than-actual-size reproduction of the book at the right can only suggest h it carries out this idea. Every one of its 1579 pages refle modern and approved practice to the same degree. Th sands of facts, figures and formulas, hundreds of diagra and tables, scores of shop standards, short-cuts, and ti savers are given—a selection of material of great range a usefulness. And though encyclopedic in scope, the book concise and compact enough to be placed on a corner your desk or bench, always ready for constant reference a instant help when you need it.

Ready reference. A list of the 45 sections of the Handbook is printed on the inside front cover. At the beginning of each of these sections there is a detailed table of contents of that section, and finally, a 15-page index at the back of the book lists over 4200 of the topics covered in the Handbook. With these three aids it is quick and easy to find the answers to your questions and problems.


19-6
THREADS AND THREADING
Table 1. Carriage Movement Between Successive Parts When Multiple-Thread Cutting
Threads per In.
Thread Multiple
Carriage Movement
Lathe Screw Threads per In.
Cannot be split this way
Any
Any even thread
Any
6
Any
Any
Cannot be split this way
Any
Any
5, 6, 9, 12
Any even thread
Any even thread
Cannot be split this way
4
(by hand) between cuts. These data give a quick and sure method of starting the second, third, and fourth threads where the lead screw is of the pitch given in the table.
To determine whether multiple threads can be spaced by carriage movement, change the threads to be cut into a common fraction. Divide the numerator by the thread multiple. If it divides evenly, the thread cannot be spaced by moving the carriage. If it does not divide evenly, move the carriage the distance obtained by dividing the thread multiple into the denominator.
The carriage can, of course, be moved 1 in. and the nut closed, no matter what the pitch of the lead screw may be (unless it is fractional), but in order to close the nut after moving 1/2 in., the screw must have some even number of threads per inch.
A lead screw with any even number of threads per inch is used in a number of cases, while in several other instances the screw may be of any pitch—either odd or even. In certain cases, 4 and 8 thread per inch lead screws are specified; and in cutting triple threads a 6 per inch screw is usual.
Helix Angle of Screw Threads. The helix angle of screw threads varies with both the diameter and the lead of the screw. The larger the diameter the less the helix angle for the same lead. The helix angle is used in grinding thread tools, and the pitch diameter should be considered instead of the outside diameter.
Helix angles are given in the tables of basic dimensions for Unified coarse, fine, extra-fine, and 8-thread series. For other diameters and leads the following helix-angle formula can be used:
P = single threads per in. ; P = lead = L.
D = pitch dia of work, in.
C = pitch circumference of work, in. = πD.

Section on Gearing. This section of 150 pages is typical of the thoroughness of the Handbook. Each machining operation—milling, turning, grinding, screw machine work, pressworking, etc., is similarly covered in a section by itself, giving methods, equipment, standards, speeds, sizes, suggestions, tables, illustrations, in profusion.

45 SECTIONS

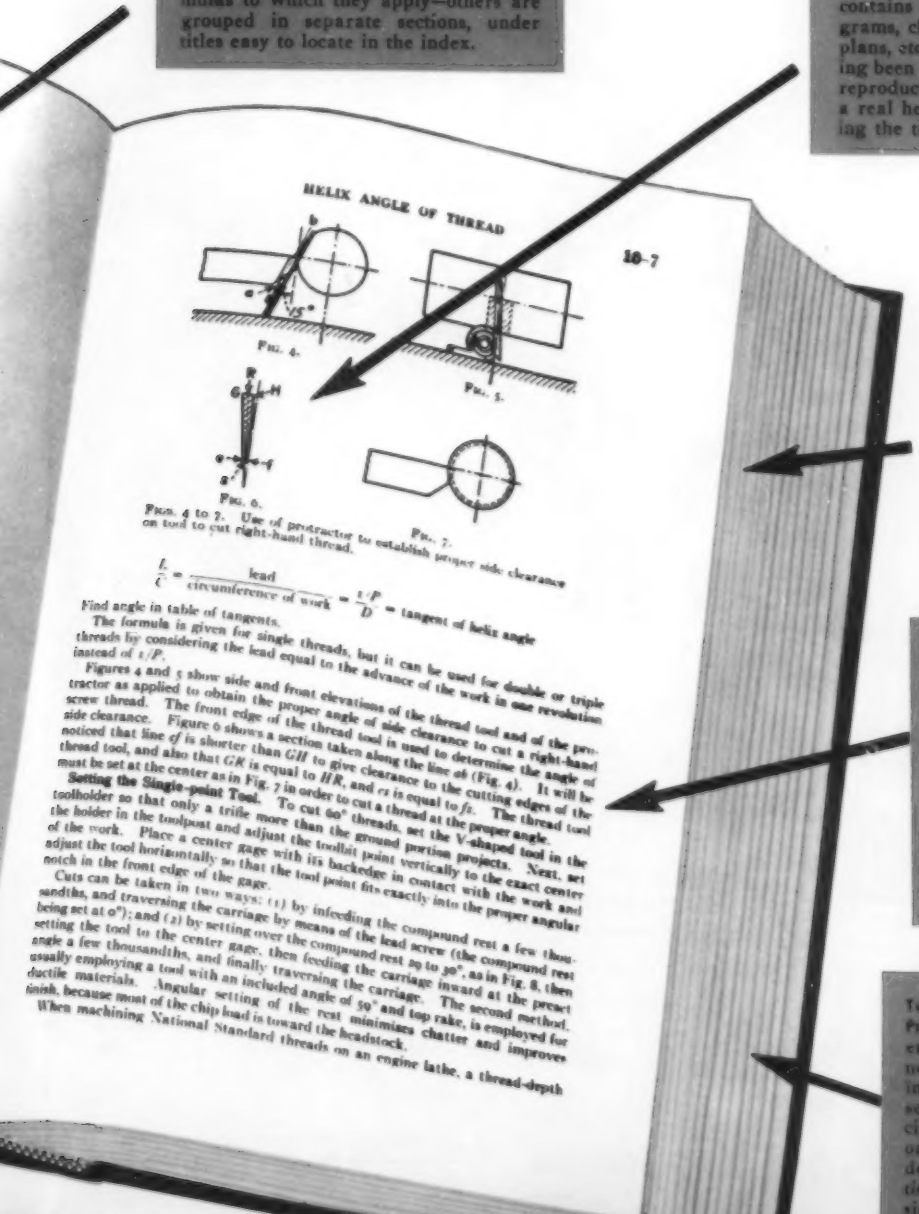
inist's HANDBOOK

to advance yourself in practical machine shop work

ggest how
ges reflects
ee. Thou-
f diagrams
and time-
range and
he book is
corner of
erence and

Tables. Hundreds of tables of sizes, speeds, tolerances, and other reference data help to make the Handbook a constantly useful tool. Many are scattered through the book as illustrated here, conveniently close to methods or formulas to which they apply—others are grouped in separate sections, under titles easy to locate in the index.

Illustrations. Of course the Handbook contains hundreds of illustrations, diagrams, charts, cross-sections, schematic plans, etc. All are especially clear, having been simplified and redrawn before reproduction, if necessary, to make them a real help in explaining and amplifying the text matter.



HELIX ANGLE OF THREAD 10-7

FIG. 4. FIG. 5. FIG. 6. FIG. 7.

FIGS. 4 to 7. Use of protractor to establish proper side clearance on tool to cut right-hand thread.

$$\frac{L}{C} = \frac{\text{lead}}{\text{circumference of work}} = \frac{t/P}{D} = \text{tangent of helix angle}$$

Find angle in table of tangents.

The formula is given for single threads, but it can be used for double or triple threads by considering the lead equal to the advance of the work in one revolution instead of t/P.

Figures 4 and 5 show side and front elevations of the thread tool and of the protractor as applied to obtain the proper angle of side clearance to cut a right-hand screw thread. The front edge of the thread tool is used to determine the angle of side clearance. Figure 6 shows a section taken along the line ab (Fig. 4). It will be noticed that line cf is shorter than GH to give clearance to the cutting edges of the thread tool, and also that GR is equal to HR, and rs is equal to ft. The thread tool must be set at the center as in Fig. 7 in order to cut a thread at the proper angle.

Setting the Single-point Tool. To cut 60° threads, set the V-shaped tool in the toolholder so that only a trifle more than the ground portion projects. Next, set the holder in the toolpost and adjust the toolbit point vertically to the exact center of the work. Place a center gage with its backedge in contact with the work and adjust the tool horizontally so that the tool point fits exactly into the proper angular notch in the front edge of the gage.

Cuts can be taken in two ways: (1) by infeeding the compound rest a few thousandths, and traversing the carriage by means of the lead screw (the compound rest being set at 0°); and (2) by setting over the compound rest 29 to 30°, as in Fig. 8, then setting the tool to the center gage, then feeding the carriage inward at the preset angle a few thousandths, and finally traversing the carriage inward at the preset usually employing a tool with an included angle of 59° and top rake, is employed for ductile materials. Angular setting of the rest minimizes chatter and improves finish, because most of the chip load is toward the headstock.

When machining National Standard threads on an engine lathe, a thread-depth

Shop Trigonometry. A useful section explains trigonometry in a simple way and gives many examples of its practical application in solving shop problems. Many tables needed in making trigonometric calculations are included.

Methods and Descriptions. The Handbook is noted for its clear, concise explanation of principles, facts, and methods of machine shop work. Although the material has been drawn from a wide variety of authoritative sources, the editor has rewritten and rearranged wherever necessary to make everything as clear and adaptable as possible for the practical shop worker.

Tool Engineering and Drafting Practice. In addition to the general reference data for tool engineers and draftsmen to be found in other parts of the book, this section gives a number of specific aids, such as reference data on jig clamps, pointers on jig design, standard drawing practice, pointers on lower cost design, mechanisms for specific

nt
TTER
NGER
STER

00
INS

— conservative
minute — higher
ble actuation.
umption
(for accurate
airborne equip-
AC hum when
r-proof housing.
enclosure with
r secured with
t and Standard-
, 40-50, and 25
oltages to 150.

resentative
erature

STRUMENT CO
Chicago 6, Illinois

cover every major phase of machine shop and drafting room work

PART 1. MACHINING METHODS

Section

1. Broaches and Broaching
2. Drills and Drilling
3. Files and Burrs
4. Gears, Splines, and Serrations
5. Grinding, Honing, Lapping, and Superfinishing
6. Milling and Milling Cutters
7. Planing and Shaping
8. Reamers and Reaming
9. Saws and Sawing
10. Threading Processes and Thread Systems
11. Taps and Tapping
12. Turning and Boring
13. Screw-machine Work

PART 2. METAL-FORMING METHODS

14. Metal Spinning
15. Pressworking and Cold-roll Forming
16. Forging, Upsetting, and Cold Heading
17. Cold Working of Metals
18. Die Casting
19. Babbitting of Bearings

PART 3. ASSEMBLY METHODS

20. Arc Welding and Surfacing
21. Gas Welding and Oxygen Cutting
22. Resistance Welding
23. Brazing
24. Soldering and Soft Solders

PART 4. MATERIALS

25. Steels and Irons
26. Nonferrous Metals
27. Heat-treatment of Metals
28. Gages, Tolerances, and Weights of Metal Products

PART 5. FINISHING OF METALS

29. Metal-cleaning Processes
30. Plating and Metal Coating
31. Paint and Painting
32. Electrolytic and Chemical Finishes of Metals

PART 6. INSPECTION

33. Limits, Fits and Tolerances
34. Measuring and Gaging Equipment
35. Tapers and Dovetails

PART 7. FASTENING DEVICES

36. Bolts, Screws, Rivets, and Washers
37. Keys and Pins

PART 8. TOOL ENGINEERING AND DRAFTING PRACTICE

38. Jig and Fixture Details
39. Drafting Practice and Engineering
40. Surface Finish

PART 9. MACHINE-TOOL STANDARDS

41. Standard Machine-tool Elements
42. Machine-tool Inspection

PART 10. POWER-TRANSMISSION EQUIPMENT

43. Chain, V-belts, and Motors

PART 11. MATHEMATICS AND TABLES

44. Mathematics
45. Reference Tables

HERE is a treasury of the kind of machine shop information that will help every man to save time and avoid trouble in his own work, to go ahead on any job with confidence, and to improve his skill, reputation, and earning power. And, over all, the shop benefits, too, in time saved in set-up and operation, in reduced delays and spoilage, and in improved results.

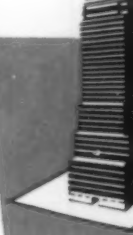
To give you clear facts—the most needed and important facts to get these benefits—plainly and conveniently presented—is the function of this Handbook. To accomplish it, years of preparation have been spent, and many sources of data and experience drawn on.

Useful facts clearly presented

Just think of being able to find the answer—the dependable answer—to almost any question—quickly—layouts, feeds, speeds, tools, jigs, fixtures, materials, standards, tolerances—any detail of machine shop or drawing room practice. On page after page, similar to the few reproduced in reduced size here, The New American Machinist's Handbook presents information that you need, in the form in which you best can understand and use it. Note that, although reduced by 35% from the actual size of the Handbook, these pages are easily readable—the illustrations are clear and simple. As to content, these few samples can only begin to suggest the scope and variety of material in the 1579-page Handbook—literally thousands of facts, easily accessible.

Metalworking practice and data, *complete*

From this book you can get facts in profusion—descriptions, definitions, methods, pointers, formulas,



10 DAYS' FREE EXAMINATION

CONVENIENT MONTHLY INSTALLMENTS

mechanisms, spring calculations, etc.

reference material—covering all the major areas of metalworking—the processes involved in manufacturing a product from raw stock (forging, casting, bar stock, or sheet metal), to the finished product (painted or plated), ready for shipment. Over 600 pages give information on machining methods from turning and boring to honing, lapping, and superfinishing. You'll find 10 basic steps, with formulas and examples, for making a milling set-up, a simplified method for indexing even though indexing tables for various makes of dividing heads are not at hand, and a concentrated section on the special requirements of drilling various different materials. Besides many sections like these, there is page after page of tabular material for constant reference.

There is much information for the designer of stampings and the die designer, and on cold working of metals including the extrusion process. Voluminous notes and sketches on good and bad practice in resistance welding and brazing—heat treatment and metallurgy for the shop man, including processing times and temperatures for a number of steels—reference data on jig clamps, pointers on jig design, pointers on lower cost design, mechanisms for specific motions, springs and spring calculations—these are just a handful of topics on which the Handbook gives you working methods and data.

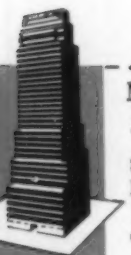
Like having a corps of experts advise you

All of this material comes from the experience of experts. Well-known shop men and engineers have assisted in compiling and checking the mass of data. Leading industrial concerns have contributed methods which they have tested and found satisfactory in actual practice. Engineering societies have opened their files of standards and specifications.. The editor writes from over 30 years' experience, both in actual shop work and in long observing and reporting the practices of leading shops all over the country. There are few who know the whole field of metalworking as well—and what is more, know from practical experience what to select, what to reject, and how to present it in the most usable form for the practical man.

A complete reference library in one handy volume

In one convenient, well-bound volume, The New American Machinist's Handbook fills all practical needs of the man in metalworking. It would take months of effort to collect, and a good-sized bookcase to hold the mass of data which Rupert Le Grand has assembled and concentrated into this Handbook for you. This service alone is worth many times the price of the Handbook.

But of even more importance is the point of having this material available *when you need it*. Think of being able to go ahead at any time, knowing that you are right—of being an authority, with the wealth of expert guidance in the Handbook behind you, on any question that may arise in practical work. Think of having the cream of the knowledge that has taken many men many years to develop right at your elbow. Weigh this against the low price of the Handbook, and decide to send for a copy at once. *Over half a million copies of earlier editions* of the Handbook have been sold—overwhelming proof that machine shop men have found the book just what they wanted for practical aid in their work. You will too; send the card today.



MAIL THIS McGRAW-HILL FREE EXAMINATION FORM

McGraw-Hill Book Co., Inc.,
327 West 41st St., New York 36, N. Y.

Send me Le Grand's THE NEW AMERICAN MACHINIST'S HANDBOOK for 10 days' examination on approval. If satisfactory I will send (Check one) ☐ $3.00 in 10 days and $2.00 a month until $11.00 is paid; or ☐ the full purchase price. Otherwise I will return the book postpaid.

SAVE! We pay delivery cost if you send remittance with this form. Same examination and return privilege.

Name.....

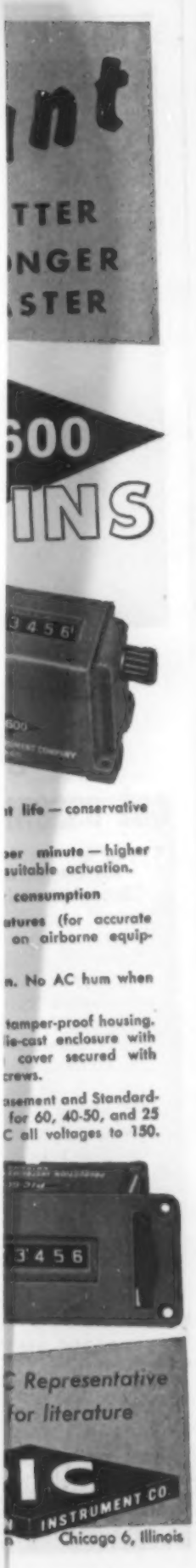
Address.....

City.....Zone.....State.....

Company.....

Position.....

For price and terms outside U. S. write McGraw-Hill Int'l., N. Y. C. PE-11



The NEW
American Machinist's HANDBOOK

Edited by RUPERT LE GRAND

• 1579 pages • 774 illustrations • 684 tables

Do you ever need information like this?

—**Rules for broaching** various materials, plus trouble-shooting

—Standard sizes of straight and taper-shank drills, plus the automotive series and small and microscopic drills

—Data on drill grinding and speeds for various materials

—**New data** on hand files, band files, rotary files, and burrs

—Exceptionally complete section on gearing, emphasizing elements of gear teeth, tooth parts, formulas for various types of gears, plus inspection details

—Details of fine pitch gears now much used in instruments and military equipment

—**How to hob** spur, helical, and worm gears

—Accurate milling of bevel gears for replacement or experimental use

—Extensive tables of grinding-wheel recommendations for various kinds of parts and materials

—Dressing and truing of grinding wheels

—Lapping of steel and cemented carbides

—**Ten basic steps** in making a milling setup

—Milling speeds for ferrous and non-ferrous metals

—Feeds per tooth for milling various materials

—How to sharpen milling cutters and end mills

—Speeds for planing with HSS, cast-alloy and carbide tools

—**Reaming speeds and lubricants** as required for various materials

—Stock allowances for reaming

—Application of power hacksaws, circular saws, bandsaws, and friction saws

—Details of six methods of cutting and forming threads

—Grinds and lubricants for radial thread chasers

—Formulas for three-wire measurement of screw threads

—**New Unified thread sizes**

—Both old and new Acme thread standards to suit needs of several industries

—New watch, instrument, and buttress threads

—The three types of American pipe threads, their elements, manufacture and inspection

—How to select machine taps and tap chasers

—Tapping speeds and lubricants

—**How to grind** a tap, particularly in reference to the hook angles for different materials

—Standard terminology for single-point tools (lathe and boring machine)

—Design and application of carbide tools

—Diamond turning and boring tools

—**Cutting-fluid selection**

—Hole-circle layouts for jig boring

—Machinability of metals and tool life

—Estimating machining time

—How to machine metals ranging from aluminum to titanium, plus plastics

—Design of form tools

—Estimating screw-machine work

—Rules for metal spinning

—**Design of stampings**

—Presswork formulas

—Punch and die clearances

—Bend allowances for sheet metal

—Springback control

—How to select a mechanical press

—Cold-roll forming of strip

—**Design pointers for forgings**

—Construction of die-casting dies

—Standard alloys used for die castings

—How to select babbitt and to babbitt a bearing shell

—Design of arc-welded joints and selection of electrodes

—**How to arc-weld** a variety of materials

—Processes and equipment for gas welding and cutting

—Good and bad practice in resistance welding 27 typical types of assemblies

—Proportions of embossed projections for resistance welding

—**Brazing alloys** and brazing temperatures

—Good and bad joints for brazing

—Kinds of solders and metals that can be soldered

—New standards for constructional and die steels

—Properties of cast irons

—Properties of aluminum, magnesium, copper alloys, nickel alloys and titanium

—Definitions of heat-treating terms

—**Heat treatments** for carbon and alloy steels

—Hardening, quenching, tempering, annealing, and normalizing of steel

—Casehardening procedures by carburizing, carbonitriding, gas nitriding, liquid nitriding, flame and induction hardening

—Hardness testing methods

—Heat treatment of tool and die steels

—Heat treatment of non-ferrous metals

—**Gaging systems** and gages for sheet metal and wire

—Dimensional tolerances of bars, sheet, strip and wire

—Weights of bars and sheet, ferrous and non-ferrous

—How to clean copper alloys, aluminum, and magnesium

—**Plating procedures** for a variety of metals

Selection and application of paints

—How to make force, shrink, and expansion fits, with charts and formulas

—Illustrations and notes on how to express tolerances and limits on drawings

—**Calculation of tolerances** for coordinates in a jig-borer layout

—The optical flat and sketches of how to check flatness, length, and parallelism

—Sine bar tables and examples

—Gage-design standards

—**Tolerances for plug and ring gages**—Mil Standard

—Tables of sizes and dimensions of machine screws, capscrews, setscrews, wood screws, tapping screws

—Sizes of standard bolts and nuts, rivets, plain washers, and lockwashers

—Dimensions of dowel, straight, clevis, taper, and cotter pins

—**Standard jig bushings**

—57 illustrations of how to apply clamps, equalizers, leaves, jacks, vises, locks, and index mechanisms to jigs

—Standard drafting practices and symbols

—**7 basic rules for dimensioning** and 43 illustrations of examples of how dimensions should be applied

—Pointers on how to achieve lower-cost designs

—Basic types of cams and linkages

—Sorting and feeding mechanisms

—Formulas and tables for design of springs

—Measurement of surface roughness

—**How to inspect a lathe** for accuracy

—Design of chain drives

—Application of hydraulic cylinders

—New frame sizes for ac motors

—Design of V-belt drives

These are just a few of the subjects covered—
typical of the many practical helps you can get from this book

SEE THE BOOK 10 DAYS FREE

Pay in small installments, while you use it

JUST MAIL COUPON INSIDE

McGRAW-HILL BOOK COMPANY, Inc.

327 West 41st Street, New York 36, N. Y.

55

Welded pressurized housing for airborne electronic equipment

Strong, sound, lightweight welded assemblies

Magnesium is easy to weld by the inert gas shielded arc method.

Welded joint strengths are high; using AZ31 alloy sheet, the joint strengths average 86% of the parent metal with all weld bead ground off smooth. If a bead is left, strengths can equal or exceed the parent metal strength.

Magnesium welds are not subject to microporosity so common with many metals. The average magnesium weld is sound and pressure-tight. Where the designer must enclose his electronic equipment in a pressurized heat exchanger, magnesium is his most satisfactory material . . . and the added bonus is light weight.

B&P engineers will help you redesign in magnesium. B&P offers the magnesium industry's most complete facilities for fabrication and assembly. Your inquiry will bring answers to problems of magnesium welding: this 12-page booklet.

BROOKS & PERKINS, INC.

1956 West Fort Street
Detroit 16, Mich.

designed to assist the reader studying on his own to become proficient in the use of methods outlined. The text accomplishes this aim very well. It is highly recommended for engineers wishing to bring their mathematical background on dynamics up to current methods.

Elements of Machine Design

EMANUEL ROSENTHAL, *Brooklyn Technical High School, and* GEORGE P. BISCHOF. *E. New York Vocational High School.* 6 x 9 *in.*, 233 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 *W.* 42 *St., New York* 36, *N. Y.* $4.50.

Theory of machine design simplified for students in technical institutes, high schools and trade schools. After a survey of metals and their properties, the text discusses problems in applied mechanics, power transmission, and stresses for dynamic loadings, and analyzes the design of principal machine parts. The treatment, based on the problem approach to learning, is rational, yet avoids the use of higher mathematics.

Analysis of Deformation—Experiment and Applied Theory

KEITH SWAINGER, *Ph.D.* (*Eng.*), *London.* 5½ x 8 *in.*, 365 *pp. Published by The Macmillan Company*, 60 *Fifth Ave., New York* 11, *N. Y.* $13.50.

"All substances deform under applied loads. This phenomenon is the aspect of natural science considered in the present work after imposing certain idealizing restrictions to bring such a wide subject within the scope of one set of mathematically linear equations." This introduced the formulation of the theory in Vol. I of this treatise and indicates the general attitude adopted.

In the second volume the theory is applied and the available experimental evidence is examined for the equilibrium deformation of various solids having various boundary conditions.

Volume I needed to be rigorous since it considered the mathematical consistency of the present theory.

(Continued on page 415)

you can

Count

▶ BETTER
▶ LONGER
▶ FASTER

with

PIC-600 TWINS

50 million count life — conservative rating.

1000 counts per minute — higher speeds with suitable actuation.

7 watts power consumption

Balanced armatures (for accurate performance on airborne equipment).

Quiet operation. No AC hum when energized.

Dust-resistant, tamper-proof housing. One-piece die-cast enclosure with close fitting cover secured with concealed screws.

Available in Basement and Standard-mount Models for 60, 40-50, and 25 cycles, also DC all voltages to 150.

Ask your PIC Representative or send for literature

PIC
PRODUCTION INSTRUMENT CO

702-10 W. Jackson Chicago 6, Illinois

WHAT'S NEW AT BRISTOL...

Automation and Bristol Through-Broached Screws cut assembly time at Burroughs

BURROUGHS, DETROIT, reports that Bristol patented Through-Broached Socket Screws, hopper-fed to a power screwdriver, cut in half the time required to insert set screws in critical stop dogs for their Sensimatic Accounting Machine.

THAT'S NOT ALL. Machine-fed Bristol screws not only eliminate a tedious hand operation, but also cut loss of screws due to dropping and cross threading.

HOPPER-FEED is no problem with the double-ended, symmetrical Bristol Through-Broached Socket Set screw. It has all the holding power of a standard socket set screw but, to facilitate machine assembly, the socket is broached all the way through so it can be inserted from either end.

Write to The Bristol Company, Socket Screw Division. A.5.5

LARGE AND SMALL—WE MAKE THEM ALL

Standard in sizes as small as No. 0 in Alloy Steel and Stainless Steel.

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

$AVINGS in $TEEL

NOW POSSIBLE WITH THE NEW

Alumicoat

Molten Aluminum Coating Process

In many cases, expensive high alloy strategic steels may be replaced with low alloy steels which have received the ALUMICOAT Molten Aluminum Coating Process. Under high temperature conditions, these low alloy steels would ordinarily oxidize and scale, but after the application of the ALUMICOAT Process, they have proven superior to strategic alloy steels.

TABLE SHOWING ALUMICOAT PROTECTION

Steel Samples	Temp. F.	Time hrs.	Change in Weight*
WITHOUT ALUMICOAT			
18-8 Chromium Nickel	1,350	24	- 17.0%
25-20 Chromium Nickel	1,350	4	- 8.3%
27% Chromium Steel	1,350	24	- 8.4%
WITH ALUMICOAT			
Plain Steel	1,350	192	+ 0.1%
18-8 Chromium Nickel	1,350	192	+ 0.1%
Plain Steel	1,700	48	+ 0.3%
18-8 Chromium Nickel	1,700	48	0.0%

*After corrosion scale was tapped off.

The above table showing ALUMICOAT protection, is a factual report of the protective capacities inherent in the application of this process to different metals at different conditions.

The Alumicoat Process has been successfully applied to Jet Aircraft Components, Petroleum Refinery Equipment, Exhaust Manifolds, Diesel Engine Components, etc. Full details of the Alumicoat Process will be furnished upon request.

ARTHUR TICKLE ENGINEERING WORKS, INC.

21-D Delevan Street • Brooklyn 31, New York • MAin 5-4200

Dormeyer

MACHINE TOOL SOLENOIDS

Dormeyer offers you the widest variety of solenoids available to industry. Engineered to your specifications from finest quality materials, they outlast equipment life.

Records show Dormeyer Solenoids in operation for over 17 million cycles are still operating as smoothly as the day they were installed! You can get this same rugged performance for your application. Prompt delivery on any quantity.

Send specifications for prompt estimate—no obligation. Request catalog.

DORMEYER INDUSTRIES

FACTORIES IN CHICAGO AND KENTLAND, INDIANA

3414 MILWAUKEE AVENUE • CHICAGO 41, ILLINOIS

Vol. II is more concerned with "practical" aspects, so that in some cases approximations have been made in the intuitive, engineering sense as required, but always indicating the nature of the approximation when compared with the rigorous theory. Thus, the present volume is intended for the research engineer, experimentalists and physicists without unduly emphasizing the mathematics from which this subject cannot be divorced. If the reader desires more detail of basic formulation, then Vol. I gives it. Other topics, such as thin plates, buckling, stress propagation, vibrations, will be treated in subsequent volumes.

Proceedings, 1954, ASTM

6½ x 9 *in.*, 1412 *pp. Published by the American Society for Testing Materials,* 1916 *Race St., Philadelphia* 3, *Pa.*, $10.

The Proceedings are published annually and include all reports and papers, together with discussions, accepted by the ASTM during the past year.

Theory of Alternating-Current Machinery

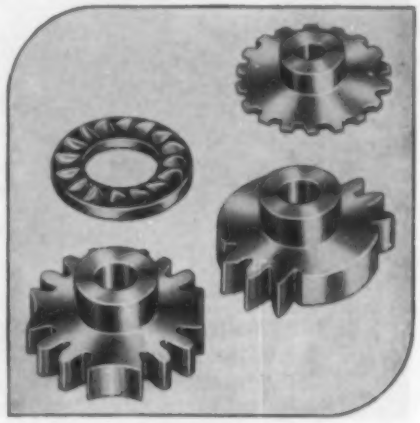
ALEXANDER S. LANGSDORF, *Dean Emeritus, Schools of Engineering and Architecture and Professor Emeritus of Electrical Engineering, Washington Univ. 2nd edition,* 9¼ x 6¼ *in.*, 666 *pp. Published by McGraw-Hill Book Co., Inc.,* 330 *W. 42 St., New York* 36, *N. Y.* $8.50.

As in the previous edition, the text covers the basic theory underlying the design and operating characteristics of all types of electromagnetic machines used in power applications. A new chapter dealing with the fundamental principles of mercury-arc rectifiers and inverters has been added.

The greater part of the original text has been rewritten and the material rearranged to enhance its understanding by the average student. Important formulas are consistently presented in terms of the rationalized mks system of units, and the terms "phasor" and "phasor diagram" are used in accordance with ASA recommendations.

Continued on page 416

Do You Wait To Be Served at Lunchtime?



Delays in personal service are annoying, but delays in deliveries can cause substantial losses in production and sales.

You can avoid these costly delays by specifying Mass Gears.

Prompt and attractive quotations can be obtained by sending your prints to Mass Gear.

G&T C

Massachusetts Gear & Tool Co.
WOBURN, MASS.

how do you handle it?

PUMP IT with a **VIKING**

Most of the nationally known companies pump many sticky liquids with P-O-S-I-T-I-V-E VIKING ROTARY PUMPS.

The Viking "gear-within-a-gear" action and port designs allow such material to readily enter the pump. The non-slip action of the gears forces the liquid out in a steady volume.

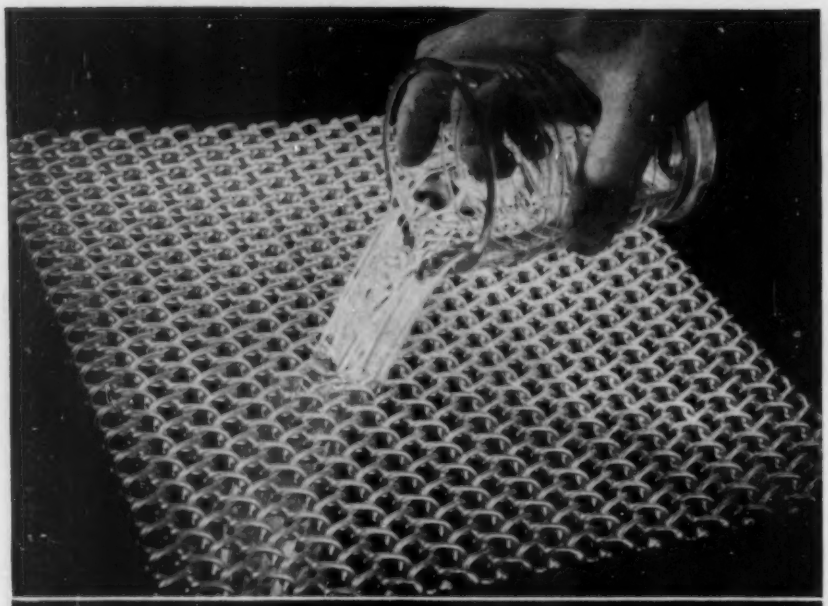
Capacities ½ to 1050 GPM. 750 cataloged models. Thousands of special designs.

Investigate today the smooth, even flow of Vikings handling either viscous or thin liquids. To start, ask for bulletin series 55Sx.

VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" pumps

THE ORIGINAL "GEAR-WITHIN-A-GEAR" ROTARY PUMP



OPEN MESH!

Cambridge

WOVEN WIRE CONVEYOR BELTS

provide continuous, low-cost processing and handling

Open mesh construction of woven wire belts lets process atmospheres circulate freely for uniform cooling, heating, drying . . . provides flash drainage of solutions, rapid washing, quenching, cleaning, draining.

Whether you're designing machines for your own operation or for resale, you can eliminate batch handling, cut costs, provide continuous production at controlled rates of speed with moving woven wire belts.

All-metal Cambridge Woven Wire Conveyor Belts are corrosion resistant and impervious to damage from constant operation at temperatures from sub-zero to 2100° F. They have no seams, lacers or fasteners to wear more rapidly than the body of the belt . . . no localized weakening.

No matter how you look at it, CAMBRIDGE Woven Wire Conveyor Belts are invaluable aids to AUTOMATION . . . help beat your biggest competition, COST. They are made in any size, mesh or weave, from any metal or alloy. Special raised edges, cross-mounted flights and other surface attachments are available to hold your product during movement.

ANNEALING BRASS PARTS...Process atmosphere circulates freely through open mesh of Cambridge belt and around small or large parts.

Call in your Cambridge Field Engineer to discuss how you can cut ultimate costs by continuous operation. You can rely on his advice. Write direct or look under "BELTING, Mechanical" in your classified telephone book.

ASK FOR FREE 130-PAGE REFERENCE MANUAL illustrating and describing woven wire conveyor belts. Gives mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P
Cambridge 11, Maryland

OFFICES IN LEADING INDUSTRIAL AREAS

This edition incorporates a radical change in the order of presentation. Chapters on circuit theory are eliminated since their content is better presented in other courses. The remaining material has been so arranged, both with respect to the sequence of chapters and the sections of individual chapters, as to enable an instructor to adapt the text to meet the need of an introductory course without destroying continuity.

New materials also include an analysis of harmonics in T-connected transformers, a topic not elsewhere presented; and new derivations of formulas for the calculation of leakage reactance and other important parameters of all forms of rotating machines. The concluding chapter on mercury-arc rectifiers and inverters is new and an important feature is the derivation of a simple formula, not given in other American texts, which summarizes the separate and combined effects of overlay and phase control upon the voltage regulation of the device.

Metal-to-Metal Adhesives For the Assembly of Aircraft

Edited by RICHARD G. NEWHALL, *Editor of Western Plastics* 8½ x 11 *in., 66 pp. Published by Western Business Publications, 274 Brannan St., San Francisco, Calif.* $4.

Anyone concerned with design of metal-to-metal adhesive-bonded structures should find this publication valuable. It is a well-edited digest of twelve papers presented at a conference on "Metal-to-Metal Adhesives for the Assembly of Aircraft", held at the University of California in Los Angeles, Sept. 9, 10 and 11, 1954, and sponsored jointly by the University of California and the Aircraft Industries Association of America.

Important factors discussed include: environmental influences and the physical nature of adhesives as bonding factors; reduction of solvent costs through applications of high viscosity adhesives by extrusion; influences which affect the bond strength on aluminum alloys; materials—and process-inspection methods—for adhesive-bonded honeycomb structures; appli-

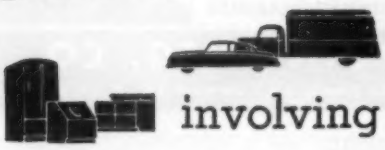
(Continued on page 417)

Silicone O rubber parts produced

by

STALWART

...can be the answer to your rubber parts problems



involving extreme temperatures

up to 500°F

down to -120°F

write today for details

ask for bulletin No. 51SR-1

6474-SR

STALWART

RUBBER COMPANY

Mfg. Plants in Bedford, Ohio and Jasper, Georgia

166 Northfield Road • Bedford, Ohio

cation of attachments to "sandwich" panels, various fastening methods that can be employed, test methods and sample test results.

Also included are: bonded-in and insert edge-bonding design methods for diffusing concentrated loading; tolerances, adaptability to adhesive bonding and structural competence of six representative sandwich-panel edge designs; tension, compression, deflection, strain and facing-stress data tables for uniformly loaded sandwich panels; evaluation of stresses existing in bonded plastic laminate lap joints; design procedure for honeycomb constructions; as well as some advantages and limitations of such design.

Most illustrations, of which there are 41, are exceptional in detail; and the 16 graphs are adequate in size and easily read.

Discontinuous Automatic Control

IRMGARD FLUGGE-LOTZ, *Stanford Univ.* 6 x 9 *in.*, 168 *pp. Published by the Princeton University Press, Princeton, N. J.* $5.

Although published in 1953 a recent emphasis on the use of discontinuous control for machine-tool applications has warranted review of this book, since available publications on this subject are scarce.

Discontinuously working elements (on-off controls) are widely used in automatic control systems. From an engineering point of view they are attractive because they are nearly always simpler, more rugged, and cheaper to build than continuous controls, but prediction of their effects in the controlled system is sometimes complicated. Owing to mathematical difficulties and the problem of avoiding unwanted transients, engineers have frequently avoided discontinuous control in systems where it would have been preferrable to continuous control. This book, with its 102 diagrams, will be welcome to engineers who prefer visual presentation to formal mathematical development. At the same time, the treatment of nonlinear differential equations given here will be important to mathematicians.

Discontinuous automatic control systems are assuming increasing im-

Continued on page 419

CROWN
MITRE GEAR UNITS

. . . transfer power at 90° angles . . . guaranteed to give satisfactory service.

Ideal for all types of right angle problems, Crown Gear Units are compact, rugged and engineered for *industrial* use. Completely enclosed, the Crown Mitre Gear Unit has a convenient lubrication port, and provides four or five mounting flanges.

Special models will be engineered and quotations submitted for any specific problem. Crown Gear Units are available almost everywhere. — Write today for your distributor's name, or engineering details.

CROWN GEAR

a division of Harrington & Richardson, Inc.
320 PARK AVENUE, WORCESTER 10, MASS.

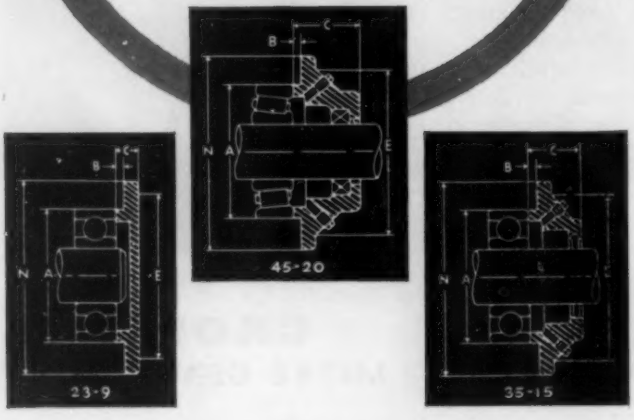
Over 120 leading distributors in 43 states, Crown Mitre Gear Units are where you want them . . . when you want them.

Sold in Canada by H. & R. Arms Co., Ltd., Montreal 23, P. Q.

FREE

YOUR PLANT EQUIPMENT FROM "NUISANCE" SET-UPS

STANDARDIZE with B-A BEARING COVERS!



Description	"A" Bearing O.D.	"B" Depth Rabbet	"C"	"E" Bolt Circle	"N"	No. and Size Bolts	Shaft	O.D. Oil Seal
#23-9	2.2500	1/8"	7/16"	3"	LUG TYPE	4-3/8"	—	—
#45-20	5.0000	3/16"	2 1/4"	6"	7"	6 1/2"	2 1/8"	3.555
#35-25	6.2992	1/4"	2 1/16"	7 1/2"	8 3/4"	6 5/8"	3 1 1/16"	FELT 3/8" x 3/16"

Savings aplenty when you standardize with B-A Standard Bearing Covers!

NO MORE "nuisance" set-ups!

NO MORE costly designing, drafting, detailing of your individual bearing covers!

NO MORE costs for patterns, jigs, fixtures, gages, etc.

... Just simply standardize with B-A Bearing Covers ... in 14 sizes, 12 types, three depths. They fit all standard size ball and roller bearings—approved by all leading bearing manufacturers.

NEW! Booklet on B-A Standard Bearing Covers . . . yours for the asking! Contains much informative design data.

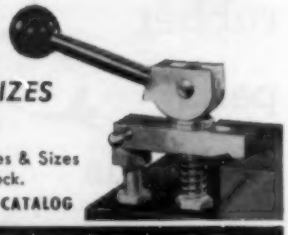
B-A STANDARD BEARING COVERS

BEARING APPLIANCE CO.
5823 GREENE STREET
PHILADELPHIA 44, PA.

WESPO for ALL WORK-HOLDING needs!

Note These Features—Reamed Holes—Hardened Serrated Bushings—High Tensile Strength Rivets

STANDARD FIXTURE CLAMPS
15 STYLES . . . 136 SIZES



COMPONENTS
Over 1000 different Types & Sizes available from stock.
Write NEW TEMPLATE for CATALOG

WEST POINT MFG. CO.
26935 W. 7 Mile Road, • Detroit 19, Michigan

Faster...pen and instrument filling

Pinpoint applicator applies just the right amount of ink, where you want it. Uses up last drop. Can't spill.

New Electro-Polarized ink gives crisp clear lines and details

Uniform color throughout bottle because it's electro-polarized to prevent settling. No shaking necessary, Carter's ink is completely opaque, uniformly black.

Drawings or renderings won't chip, peel or crack. Get the bottle that is the applicator .... Carter's Squeeze Bottle India Drawing Ink. — Conventional Bottles too, for brush work and dip pens.

Sold by leading Art, Blueprint, Drafting, Engineering and Stationery Suppliers

THE CARTER'S INK COMPANY • Cambridge 42, Mass.

portance in engineering applications, especially in devices such as missiles, which must be expendable. Dr. Flugge-Lotz, who pioneered in this field in Germany and now continues her research at Stanford University, has shown how tedious computations can be replaced by graphical solutions. This study shows that for many purposes discontinuous control can work as well as continuous control, and that certain undesired phenomena can easily be avoided by a correct choice of the control characteristics.

Pipe Friction Manual

Hydraulic Institute. 8½ x 11 *in., paperbound, 87 pp. Published by Hydraulic Institute,* 122 *E. 42 St., New York* 17, *N. Y.* $1.75.

Material in this manual is an extension and rearrangement of the pipe friction data contained in an earlier publication entitled "Tentative Standards of the Hydraulic Institute—Pipe Friction." The data is based on information derived from twenty-two listed references.

Included are: tables of friction loss for water in feet per 100 ft of wrought iron, steel and cast iron pipe in sizes from ⅛ to 84 in. dia; resistance coefficients for pipe bends, valves and fittings; graphs of friction loss for incompressible flow of viscous fluids for pipe sizes from ¼ through 12 in.; viscosity index of various fluids; viscosity conversion tables; and sample computations of various flow circuits. Basic pipe friction and viscosity formulas are given on the basis of construction of the various charts and tables.

Plastics Tooling

Malcolm W. Riley. 5 x 7 *in., 123 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York* 22, *N. Y.* $2.50.

This sixth book of a series of pocket-size on timely subjects of interest to engineers and technicians is on plastic tooling. It is in the form of a status report bringing up-to-date information on resins, methods used and major applications.

It is pointed out that use of plastics

(Continued on page 421)

NEW step-base DESIGN

NOW AVAILABLE IN
THE BASIC AND POPULAR

ACRO

SNAP-ACTION "C" SWITCH

- PROVIDES LOWER COST, SCREW TERMINAL CONSTRUCTION
- SIMPLIFIES CONNECTION TO TERMINALS

The popular Acro "C" Switch has had its base lifted! Now the *open terminal* is located on a raised pad at the midpoint of the switch base. The *closed terminal* and the *common terminal* are at opposite ends of the base and at a lower level. These three, widely spaced screw terminals provide maximum clearance. Switch users will benefit from the lower costs of installation.

Mechanically this Acro snap switch utilizes the famous Acro rolling spring principle proved superior through over 25 years of service. It's the ideal switch for *tough* and *must* services such as aircraft and machine tools where maximum durability and vibration resistance are required. It's available with all types of actuators. Write for data sheet today.

ACRO SWITCH DIVISION

ACRO MANUFACTURING COMPANY

COLUMBUS 16, OHIO

Plants at Columbus and Hillsboro, Ohio

REPRESENTATIVES IN ALL PRINCIPAL CITIES

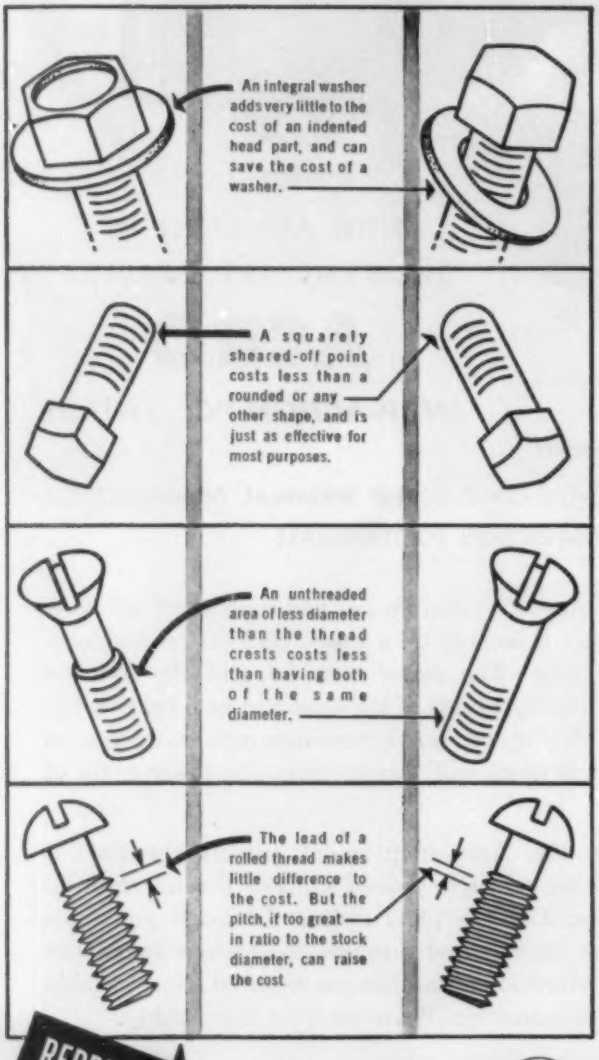
MORE WAYS TO

SQUEEZE PENNIES

OUT OF

UPSET SPECIALS COSTS

Specially designed upset products are solving thousands of problems. Dozens of design pointers on them are yours for the asking. Send us your sketches, prints, finished products for suggestions.


An integral washer adds very little to the cost of an indented head part, and can save the cost of a washer.
A squarely sheared-off point costs less than a rounded or any other shape, and is just as effective for most purposes.
An unthreaded area of less diameter than the thread crests costs less than having both of the same diameter.
The lead of a rolled thread makes little difference to the cost. But the pitch, if too great in ratio to the stock diameter, can raise the cost

REPRINTS *of this chart are available on request for use in drafting and purchasing departments.*

QUALITY PROMCO BRAND

A HALF-CENTURY OF MACHINE SCREWS AND SPECIAL FASTENERS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY

48 NORWOOD ST., TORRINGTON, CONN.

Imperial

the world's finest

TRACING CLOTH

In drafting rooms throughout the world Imperial quality is the standard by which fine tracing cloths are judged. This has been true for decades, and Imperial remains the finest tracing cloth because its makers have continued to improve its quality and value.

VULCAN

ELECTRIC HEATING UNITS

IMMERSION

The most efficient and usually the most convenient method of heating liquids in tanks, boilers, urns, kettles, etc.

STANDARD SIZES

FOR WATER: Single Heat, 500 to 3000 watts. Three Heat, 500 to 10,000 watts.

FOR FUEL OIL PRE-HEATING—OIL and WAX HEATING: Single Heat, 500 to 1000 watts. Three Heat, 1000 to 6000 watts.

Larger and smaller sizes made to order, as well as units to suit special applications.

Bayonet and Bottom Outlet types, too.

VULCAN ELECTRIC COMPANY
DANVERS 18, MASS.

Heating Units for any device that uses electric heat. Electric Soldering Tools, Electric Glue Pots, Solder Pots and Melting Pots. Electric Branding Irons. See 8-page Vulcan catalog in Sweet's Product Design File for 1955.

can often result in lower cost tools, faster tool delivery, lighter-weight tools, easy duplication of tools, easy repair of tools, and tools that resist corrosive atmospheres. Applications appear most interesting for short-run parts production. Limitations lie primarily in inability of plastics to withstand high temperatures, relatively poor dimensional stability compared to metal tools, and possible health problems in making the tools.

The hurried reader could well pass over the first three chapters which are principally historical and apparently written for the novice. Chapters 4 through 10 contain much useful information and are well written. Both advantages and disadvantages of using the various plastics for tooling applications are frankly and clearly stated. Well worth the hour or so required for reading.

Patent Law in the Research Laboratory

JOHN K. WISE. 5 x 7 *in.*, 145 *pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.* $2.95.

Patent legislation in the past few years, while primarily a codification of the former law, provides for many of the problems inherent in patents originating in the research laboratory. The author attempts to clarify the significance of the new law on the basis of its history and with numerous references to individual case histories. The statutes are, of necessity, enunciations of principles. The courts decide how these principles apply. While describing the broader applications of patent law the author pays particular attention to its reference to the research laboratory.

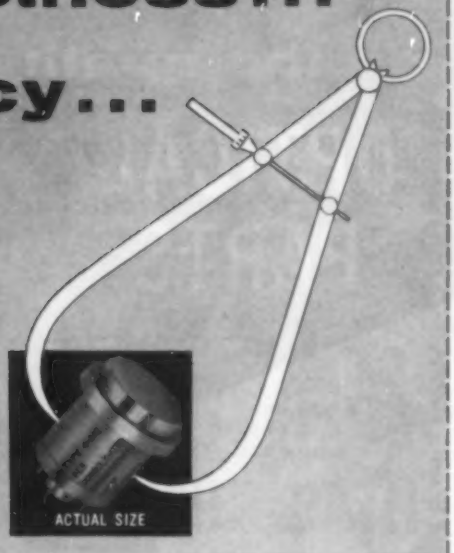
The group research common in large industry greatly complicates the legal problem. Such questions arise as: who is the inventor, and must the invention be discovered in a flash of creative genius or can it be accomplished after long, hard, careful, well-planned work.

More concerned with guiding principles than individual detail the author avoids long, legalistic argument which would be of little interest to the layman, thereby providing an in-

(Continued on page 422)

compactness...

accuracy...



get both with—

CEC PRESSURE PICKUPS

What surprises most engineers the first time they see one of CEC's 4-300 Pressure Pickups is its small size. But when they learn of the performance, surprise often turns to amazement. With the 4-300's, there's no compromise on either compactness or accuracy . . . you get *both* in a single unit, with ruggedness that provides laboratory accuracy under the most adverse conditions of use.

For your next pressure measurement job . . . where you need high accuracy, rapid response and minimum size . . . check these important features, common to all CEC 4-300 Pressure Pickups . . .

WIDE CHOICE OF RANGES . . . gage, absolute and differential units . . . full-scale ratings low as 1 psi, high as 5000 psi.

ACCURACY . . . 0.75% maximum linearity deviation...unusually low hysteresis, temperature effects, and acceleration response.

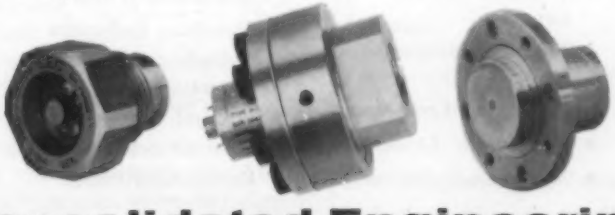
EXTREME MINIATURIZATION . . . bodies as small as ½" in diameter.

STANDARDIZATION . . . same basic sensing element in all models . . . uniform excitation voltage and output greatly simplify system design and operation.

COMPLETE CALIBRATION CERTIFICATE . . . *all* characteristics measured . . . signed certificate sent with each pickup.

ADAPTABILITY...several mounting methods offered as pictured below . . . standard fittings supplied.

There's a CEC Pressure Pickup for almost every purpose. For complete information let us send you Bulletin CEC 1552-X29.



Consolidated Engineering

Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D.C.

Production-run savings on top quality

OPTICAL PARTS

Rush Delivery!

To meet your design specifications . . . immediate delivery of samples, prompt action on volume orders for manufacture. Choose from catalog stock: hundreds of different optical parts, production-run to the optical industry's highest precision standards.

- Plano-Convex Lenses
- Double-Convex Lenses
- Double-Concave Lenses
- Plano-Cylinder Lenses
- Positive Meniscus Lenses
- Negative Meniscus Lenses
- Projection Condensers
- Achromatic Lenses
- Right Angle Prisms
- Crown Glass Wedge-Type Prisms
- First Surface Reflectors —Plane
- Second Surface Reflectors—Plane
- Parabolic Reflectors
- Cylindrical Strip Lenses
- Ground Glasses
- Heat Absorbing Glass
- Retardation Plates

WRITE for Catalog L-117 and for information on special orders. Bausch & Lomb Optical Co., 66847 St. Paul St., Rochester 2, New York.

BAUSCH & LOMB
SINCE B&L 1853

teresting and readable introduction to a difficult subject.

The major subjects discussed include: patent history, what is patentable, what rights a patent confers, how a patent is applied for, granted and transferred.

Engineering Mechanics

ARCHIE HIGDON, *Col., USAF, Acting Hd., Dept. of Mathematics, USAF Academy, and* WILLIAM B. STILES, *Prof. and Hd., Dept. of Engrg. Mechanics, University of Alabama.* 6¼ x 9 *in., 585 pp. Published by Prentice-Hall, Inc., 500 Fifth Ave., New York, N. Y.* $7.95.

This is the second edition of a good basic text on mechanics. The authors have revised and reorganized their material to present better the subject. Primarily, this work is aimed at engineering students.

The contents include: Basic Concepts; Resultants of Force Systems; Centroids and Centers of Gravity; Equilibrium; Friction; Second Moments or Moments of Inertia; Method of Work; Kinematics—Absolute Motion; Kinematics—Relative Motion; Kinetics—Force, Mass and Acceleration; Kinetics—Work and Energy; Kinetics—Impulse and Momentum; Mechanical Vibrations; Answers to Problems; and Index.

Analysis of Feedback Control Systems, Servomechanisms and Automatic Regulators

ROBERT A. BRUNS, *Research Engr., Jet Propulsion Lab., California Institute of Technology, and* ROBERT M. SAUNDERS, *Assoc. Prof. Electrical Engrg., Univ. of California.* 6 x 9 *in., 383 pp. Published by Princeton University Press, Princeton, N. J.* $7.50.

This new book presents a logical, rigorous, and readily understandable treatment of feedback control components and systems. The most recent literature in the field has been surveyed and evaluated in presenting a unified method of analysis consistent with the technical background of those new to the field. Unique features add unusual interest to this new

(Continued on page 423)

CAN YOU USE COLD MOLD METAL

For:

- Fixtures
- Laminations
- Prototypes
- Build-Ups
- Core Boxes
- Holding Jigs
- Embossing Dies
- Mold Repairs
- Vacuum Molds
- Match Plates

Other Uses

Here is a new aluminum compound that promises to simplify many production procedures. It's a free-flowing metal that casts cold yet hardens solid at room temperatures without heat or pressure. Cold-Mold is simple to use. Intricate jigs, dies, patterns and other parts and tools can be formed as easily as plaster is poured. The hardened metal is dimensionally stable, may be worked with ordinary tools and plated with other metals.

See for Yourself

We can't begin to know all the jobs Cold-Mold can do; but perhaps our technical bulletin will suggest applications in your field.

WRITE,

the sculp-metal company

701-3 Investment Bldg. Pittsburgh 22, Pa.

Molded

BLACK NYLON SCREWS and NUTS

Insulate and fasten without bushings, washers, etc.
In stock 6-32, 8-32, 10-32

NyGrip **BLACK NYLON Cable Clips**

Light-weight non-conducting support for wiring, tubing, etc.
In stock 1/16" to 1½" dia.

Free Samples...Write

WECKESSER CO.

5265 N. Avondale Avenue • Chicago 30, Illinois

work, which should enable the reader to analyze systems of considerable complexity and to develop an excellent background for synthesis techniques. No other book covers the field so completely, nor in the same manner; the survey of components together with a sound approach to system theory is not found elsewhere.

The frequency response approach is used throughout. Emphasis on this approach, for which a-c circuit analysis is the only prerequisite, makes the transfer function method of analysis the most important feature of the book. Thus, in the ten chapters devoted to component theory, the basic physical laws governing the behavior of components are interpreted in terms of their transfer functions without the introduction of new mathematical concepts. Components covered are not in any one field, but include electrical, magnetic, mechanical, pneumatic and hydraulic elements.

The authors emphasize the implementation of systems by giving the student the basic theory of components. Recent developments in nonlinear and discontinuous systems, particularly the describing-function method, are included. Illustrative examples are used literally, especially in the system theory chapters.

How to Train Engineers In Industry

Prepared by the Professional Engineers Conference Board of Industry. 6 x 9 in., paper-bound, 72 pp. Published by the Professional Engineers Conference Board for Industry, 1121 Fifteenth St., N.W., Washington 5, D. C., $2.

This report is the result of the fourth of a series of Executive Research Surveys, begun in 1951 by the Professional Engineers Conference Board for Industry with the cooperation of the National Society of Professional Engineers.

Previous surveys indicated that advantages most frequently sought by graduates were orientation, stimulation and challenge. It was to determine how these qualities can be built into a training program that the present survey was made. Questionnaires were sent to more than 500 leading firms and field investigations were made in a

(Continued on page 425)

Tear off and Mail this Ad TODAY!

—for the valuable

FREE SIER-BATH GEAR DIAGNOSIS

showing how

Sier-Bath Gears can effect economies and promote the sale of your machines

•

Mailing this ad incurs no cost or obligation

Mr.....

Title.....

Company.....

Address.....

City.....State.....

•

Mail this ad today, to

Sier-Bath

GEAR & PUMP CO., Inc.

9238 Hudson Boulevard
North Bergen, N. J.

50th Anniversary Member A.G.M.A.

Everybody talks about Quality

Quality
Quality
Quality
Quality
Quality

At "CHICAGO" we DO something about it!

- **Metallurgical Control of raw materials**
- **Statistical quality control regulates all manufacturing operations**
- **Carbon restoration method of heat treatment eliminates decarb on heat treated products.**

Chicago Screws will assemble faster, with fewer rejects, and with a measurable reduction in costs.

Progressive action plus better methods of manufacture have kept "Chicago" out in front for 83 years.

"Chicago" Products are carried in stock by your favorite service-conscious Industrial Supply Distributor. Call him today. He can serve you promptly from his complete stocks—whether it be a package or a carload.

404

CHICAGO SCREWS

The CHICAGO SCREW COMPANY
ESTABLISHED 1872
2507 Washington Boulevard
Bellwood, Illinois

The complete Chicago "Safety Plus" line includes in alloy steel: Socket Set Screws • Socket Head Cap Screws • Socket Stripper Bolts • Square Head Dog Point Set Screws • Socket Pipe Plugs • Flat Head Socket Cap Screws • Dowel Pins • Hexagon Keys and Key Kits • Also Socket Set Screws and Socket Head Cap Screws in Stainless. The complete "Chicago" line of Standard Products includes: Hexagon Head Cap Screws in steel—bright and Grade 5, heat treated, also in brass and stainless • Square Head and Headless Set Screws • Taper Pins • Steel Studs Flat and Fillister Head Steel Cap Screws • Hexagon Nuts in steel, brass and stainless.

MARSH MAKES IT!

If it's a pressure gauge or dial thermometer, Marsh makes it . . . and makes it better. The types, ranges and case styles are endless. What is "special" to other instrument makers is often standard to Marsh. To know the scope of Marsh instruments—

Write for this fact-filled catalog

MARSH INSTRUMENT CO. Sales Affiliate of Jas. P. Marsh Corporation
Dept. 39, Skokie, Ill. • Marsh Instrument & Valve Co. (Canada) Ltd., 8487 183rd Street, Edmonton Alberta • Export Dept., 3501 Howard Street, Skokie, Ill.

ROLL YOUR MARKS WITH RUBBER

For
SHEETS
COILS
TUBES
BARS
ASSEMBLIES

For inexpensive, engineered marking, use a Matthews free-rolling Industrial Rubber Marking Unit. Easily attached to your production line, you can mark trade names, numbers, codes or other information at the same speed the material is being fed. Or, if you prefer, a hand-held unit can be used to mark your products off the production line.

Let Matthews offer its recommendations . . . write today for complete information and literature.

JAS. H. MATTHEWS & CO.
3962 FORBES ST. • PITTSBURGH 13, PA.
CLIFTON, N. J. BOSTON CHICAGO PHILADELPHIA

number of large and small plants where training programs were in operation.

The topic under study were selected by some 100 major industrial employers of engineers. These topics cover typical training programs, orientation, evaluation, and the costs to industry of training programs.

The survey indicates that industry recognizes its responsibility for developing its technical employees after graduation and nearly all companies now have some sort of training program for new employees. Some employers assist the graduate to earn advanced degrees in recognized courses within the company or by paying tuition fees to nearby engineering colleges. Managerial development programs are also being prepared to meet the need for management executives.

Among the recommendations for further work in this field are:

1. Increased attention to supervision and guidance for the young engineer.
2. More opportunities for advanced studies.
3. More cooperation among industrial plants, schools, professional societies and community groups.
4. More communication between employers about training methods and techniques.
5. Stimulation of engineers' interests in community and cultural activities.
6. Further encouragement of professional registration and participation in professional society activities.

Elements of Electronics

HENRY V. HICKEY, *Chief Radio Electrician, USN and* WILLIAM M. VILLINES, *Lieutenant (jg) USN.* 6¼x9¼ *in.,* 487 *pp. Published by McGraw-Hill Book Co., Inc.,* 330 *W.* 42 *St., New York* 36, *N. Y.* $5.

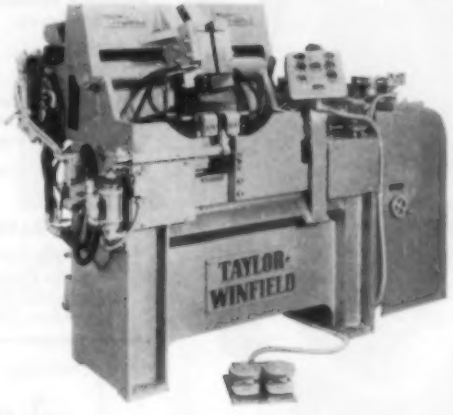
This is a new text in basic electronics which contains a maximum of practical information and a minimum of unnecessary data in covering the field of basic electricity and electronics. This book is recommended reading for the mechanical engineer who would become familiar with the basic principles of electronics with a minimum of study.

The book does not require supple-

(Continued on page 427)

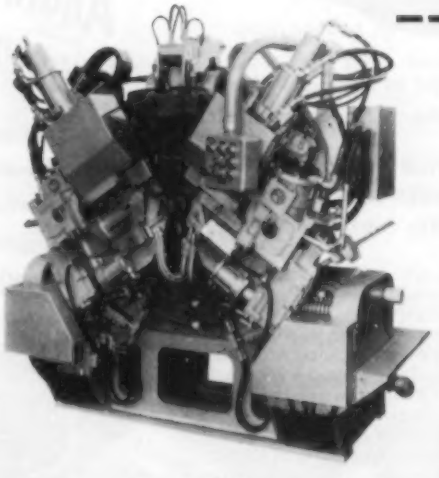
A Standard T-W Resistance Welder

Versatile uses; prompt delivery; lowest price.



Or A Standard Welder Modified

Special tooling; special time cycle; increased production; low-cost re-tooling.



Or A Special Welder Designed for Your Work

Volume production at lowest unit cost.

Resistance Welders Since 1898

TAYLOR-WINFIELD

RESISTANCE WELDERS

SPOT • PROJECTION • SEAM • FLASH-BUTT

THE TAYLOR-WINFIELD CORPORATION

Sales and Service

CHARLOTTE • CHATTANOOGA
CHICAGO • CLEVELAND
DALLAS • DAYTON • DENVER
DETROIT • LOS ANGELES
PHILADELPHIA • PORTLAND, OREGON • SEATTLE • ST. LOUIS
STAMFORD • WASHINGTON
OAKVILLE AND WINDSOR, ONTARIO

WARREN, OHIO

CUTLER-HAMMER'S NEW

"Immunized"

H. D. PUSHBUTTON STATIONS

Widely used in chemical plants, mining operations, paper mills, etc.

NOW AVAILABLE FOR SERVICE IN CORROSIVE ATMOSPHERES, TEMPERATURES TO 83° BELOW ZERO, SUN, SALT, ICY SLEET, OIL AND DUST

Cutler-Hammer is proud to announce its 10250 D-70 Heavy Duty Pushbutton Stations enclosed in weather and watertight case virtually immune to corrosive atmospheres, temperatures to 83° F. below zero, and 125° F. above zero, to continued exposure to sun rays, salt spray, sleet, rain, oil, dirt and dust. Pushbutton operators cannot freeze. Pushbuttons operate by finger pressure upon a silicone-rubber and orlon diaphragm with tremendously long flexing life. No way for sleet or corrosion to prevent button operation—no way through to operating mechanism short of taking station apart. Classified NEMA 3, also meets NEMA 4 and 5 specifications.

Many stations used in chemical plants, mining operations, by paper-making companies, etc. Especially recommended for deep-freeze lockers, packing plants, dairies, breweries — to withstand corrosive action or regular sluicing down with hose.

In one, two and three pushbutton designs; wide variety of control circuits. Write for further information and tell us your needs. CUTLER-HAMMER, Inc., 332 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

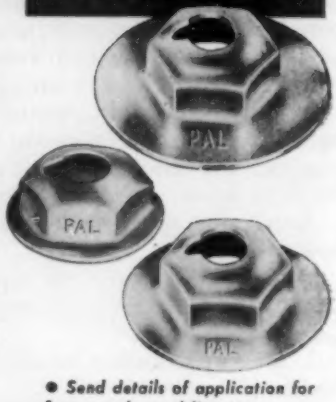
CUTLER-HAMMER
MOTOR CONTROL
C-H

Why assemble 3 parts?

..when 1 part does the job at lower cost!

- One-piece lock nut and flat washer costs much less than ordinary nut, lock-washer and flat washer—frequently no more than an ordinary nut alone
- Vibration-proof fastening for sheet metal assemblies, components, parts and other light types of assemblies
- Saves parts and handling
- Speedy assembly with hand or power drivers
- Built-in washer spans holes and slots
- Resilient spring action provides safe, secure fastening when used on fragile parts
- Wide range of standard sizes

WASHER TYPE
PALNUT
TRADE MARK®
LOCK NUTS

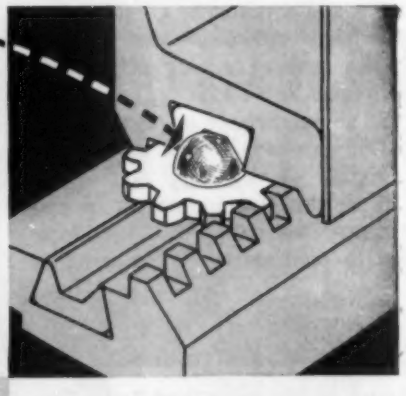


The PALNUT Co.
65 Cordier St., Irvington 11, N. J.
In Canada
P. L. Robertson Mfg. Co., Ltd.
Milton, Ontario

● Send details of application for free samples and literature.

Another Example

of how Hartford makes Typewriters Function smoothly



Royal Typewriters are famous the world over for their *light touch and ease of action . . . Hartford* ball: and bearings help. For example, every Royal carriage moves laterally on a *Hartford low friction sliding linear bearing.* Precision Chrome Steel Balls in gear-like cradles assure smooth responsive carriage action and easy operation of the escapement mechanism.

WHAT IS YOUR BEARING PROBLEM?

Hartford engineers will gladly assist you on any bearing problem that requires precision balls, retainers or bearings made to your specifications.

Hartford
PRECISION BALLS • BEARINGS

The Hartford Steel Ball Co., Inc., 3 Jefferson Ave., W. Hartford 6, Conn.

mentary reading and includes basic trigonometry and vector algebra required for the study of inductive and capacitive relationships.

The early chapters of the book introduce the fundamentals of electricity and simple vacuum tube circuits. Considerable space is then devoted to the d-c and a-c measuring instruments, their theory of operation and use. Later chapters include a study of the laws and properties of inductance and capacitance, and series and parallel circuits containing these elements.

Sources of power include batteries, d-c and a-c generators, and electronic power supplies are discussed in detail. Later chapters cover the theory of various functional electronic tube circuits in detail. A final chapter on transistors is also included.

Special Slide Rules

JOSEPH T. HOGAN, *Chemical Engr.* 8½ x 11 in., 7 pp. *Available from Joseph T. Hogan, 2713 N. Roman St., New Orleans, La.* $0.35.

A list of 48 special slide rules and where they can be obtained. Each rule aims to simplify the solution of some complex problem or equation. Each entry in the listing includes the name of the slide rules, name and address of the manufacturer or distributor, year of copyright or publication, and where necessary, a brief description of the function or use of the rule.

Bibliography and Index on Dynamic Pressure Measurement

W. G. BROMBACHER and T. W. LASHOF, 10¼x7¾ in., 124 pp. *Available from U. S. Govt. Printing Office, Washington 25, D. C.* $0.75.

This book contains a bibliography of 850 items on dynamic pressure measurement and also on related subjects such as static pressure measurement and general information on the components of pressure instrumentation.

The definition of dynamic measurement, for the purposes of this book, is: If a measurement can be made while the pressure or other quantity is changing, even slowly, the instrument is considered to be a dynamic one. This bibliography therefore in-

(Continued on page 428)

Gering will show YOU
AN
EXTRUSION

• flexible and rigid plastic
• all sizes, shapes, profiles

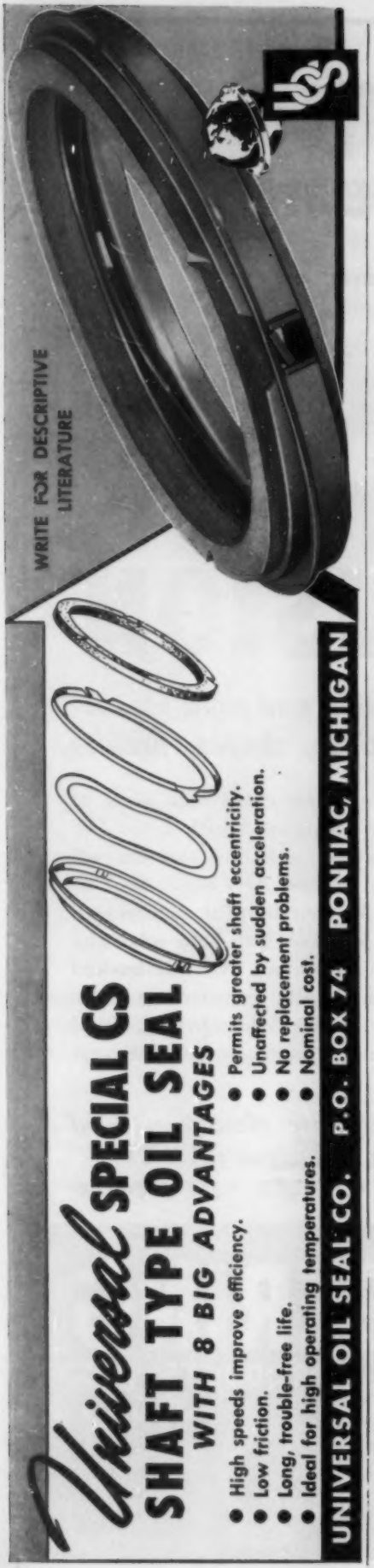
The most complete extrusions plant in the world—equipped with 2″ to 10″ extruders, with dies and take-off equipment to serve ANY need, stock or special—PLUS our helpful engineering and design staff to help solve any blueprint problem. All this backed by our extensive all-over activities in the Thermoplastics field. Quality, small or large quantity, quick delivery.

Polystyrene • Cellulose Acetate • Vinyl
Ethyl Cellulose • Butyrate (TENITE II)
Polyethylene • Acrylic • Copolymers

Extruded Products Division
GERING
PRODUCTS • INC.
KENILWORTH, N. J.

• SERVICE
• QUALITY
• DEPENDABILITY

BRANCH Offices: Chicago, Ill., Mansfield, Ohio; Cleveland, Ohio; Detroit, Mich.


WRITE FOR DESCRIPTIVE LITERATURE
Universal SPECIAL CS
SHAFT TYPE OIL SEAL
WITH 8 BIG ADVANTAGES
• High speeds improve efficiency.
• Low friction.
• Long, trouble-free life.
• Ideal for high operating temperatures.
• Permits greater shaft eccentricity.
• Unaffected by sudden acceleration.
• No replacement problems.
• Nominal cost.
UNIVERSAL OIL SEAL CO. P.O. BOX 74 PONTIAC, MICHIGAN

cludes many instruments ordinarily classed as "static", including liquid columns and piston gages where means for securing the dynamic measurement are devised.

A limited number of references are included on basic design and performance factors such as drift or creep, hysteresis, and temperature coefficient of elasticity on important diaphragm, electrical resistance and piezoelectric materials and on seals and solders.

Auxiliary apparatus including amplifiers, electrical circuits and circuit elements, timers, indicators, and recording methods and telemetering are referenced along with performance of instruments and instrument elements, pressure lag in connecting lines, electrical cable problems, and static and dynamic calibration methods pertinent to dynamic instrumentation.

Basic Lubrication Practice

ALLEN F. BREWER, *Consulting Lubrication Engr.* 6 x 9 *in.*, 286 *pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.* $6.75.

A broad, rather superficial discussion of lubricants and industrial lubrication methods and problems rather than a detailed analysis of lubrication theory and design practice. However, several charts and tables are included to help compare lubricants for specific machinery under various operating conditions.

Although much of the information may be of interest to design engineers who are not well versed in lubrication, the principal audience for this book is maintenance engineers, executives, purchasing agents and machine operators.

Electroplating Engineering Handbook

Edited by A. KENNETH GRAHAM, *Pres., Graham, Crowley and Assoc., Inc.* 7 x 10 *in.*, 650 *pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York, N. Y.* $10.

A very complete handbook prepared for electroplaters and those responsible for setting up and supervising electroplating operations. Nevertheless, it is an excellent reference book for de-

(Continued on page 429)

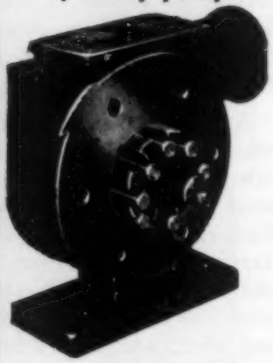
KRAISSL • Since 1926 • in the application, design and mfg. pumps—separators—hydraulic accessories.

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary Oil Pumps • Vacuum Powered Transmission and Low Pressure Air Service • Air and Liquid Filters •

What's your problem?

√ higher pumping speeds?
√ tolerance of particle-laden liquids?
√ peak suction for primary pumps?



the Kraissl-50 Roller Pump

is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller - rotor design easily handles particles that would jam more tightly - fitted mechanisms — reduce cavitation, allowing higher speed operation* — develops high suction characteristics.

* *Roller mechanisms permit higher speeds with any oil than most displacement designs.*

KRAISSL KRAISSL CO
289 Williams Ave., Hackensack, N. J.

signers. Besides covering all aspects of the preplating, plating and post-plating operations, a glossary cf electro-plating terms is included and a 9-page section on designing parts for electro-plating.

The design section is written by C. F. Nixon, Hd., Electro-Chemistry Dept., Research Labs. Div., General Motors Corp.; D. M. Bigge, Hd., Chemical Lab., Central Eng., Chrys-ler Corp.; and W. L. Pinner, Mgr., Process Development Div., Houdaille-Hershey Corp.

Over forty contributors, renowned in the field, supplied the material incorporated in the book. Under the direction of A. Kenneth Graham, a total of eight editors compiled the material, which includes many charts, tables and graphs. The book is well edited and easily read. It is particularly well suited for reference because of the bold paragraph cross-headings used and a 24-page comprehensive index.

Hydraulic Operation and Control of Machines

IAN MCNEIL. 5½ x 8½ *in.*, 324 *pp. Published by Ronald Press Co., 15 E. 26 St., New York 10, N. Y.* $7.50.

Originally published in Great Brit-ain, this book provides a welcome ad-dition to the limited literature on practical hydraulics as a power trans-mitting medium. In the opening chap-ters, theoretical considerations are dis-cussed covering hydrostatics, viscosity, fluid flow and compressibility. Em-phasis here is on qualitative rather than precise theoretical analysis.

Hydraulic pumps and motors are covered in their functional and oper-ating characteristics. The major valve types available are described and sim-ple sketches amply illustrate their function. Space is also given to accumulators, intensifiers, hydraulic fluids, seals and packings, pipes, hy-draulic fluids, and torque conversion devices.

Perhaps of most practical value to the user of hydraulic equipment is the latter half of the book in which the application of hydraulic power to the control of various machines is de-scribed. Forging presses and the ex-trusion process are illustrated with functional sketches and photographs.

(Continued on page 431)

Kearfott Servo Motor-Generators are characterized by low rotor inertia, low time constants and high stall torque. Motor-Generator combinations pro-vide ½ to 3.1 volts per 1000 R.P.M. with an extremely linear output over a speed range of 0—3600 R.P.M. and useful output up to 10,000 R.P.M.

CHARACTERISTICS				
TYPE	MOTOR		GENERATOR	
	STALL TORQUE	NO LOAD SPEED	OUTPUT FUND. NULL	LINEARITY
DAMPING				
SIZE 10	.35 OZ. IN.	6000	21/1	.5%
SIZE 10	.30 OZ. IN.	8500	23/1	.5%
SIZE 11	.63 OZ. IN.	5900	25/1	.5%
SIZE 15	1.5 OZ. IN.	5000	25/1	.5%
SIZE 18	2.4 OZ. IN.	5000	25/1	.5%
SIZE 18	3.0 OZ. IN.	9600	23/1	.5%
RATE				
SIZE 15	.45 OZ. IN.	10,500	170/1	.5%
SIZE 15	1.5 OZ. IN.	4700	350/1	.2%
SIZE 18	2.4 OZ. IN.	4700	350/1	.2%
SIZE 18	3.0 OZ. IN.	8400	350/1	.2%
*INTEGRATOR				
SIZE 15	.70 OZ. IN.	6300	400/1	.1%
SIZE 15	1.25 OZ. IN.	4500	400/1	.1%
SIZE 18	1.35 OZ. IN.	7200	400/1	.1%
SIZE 18	2.4 OZ. IN.	5200	333/1	.05%
SIZE 18	3.0 OZ. IN.	8000	333/1	.05%

*Integrator Tachometers are temperature stabilized

Send for Bulletin describing Servo Motor-Generators of in-terest to you.

ENGINEERS

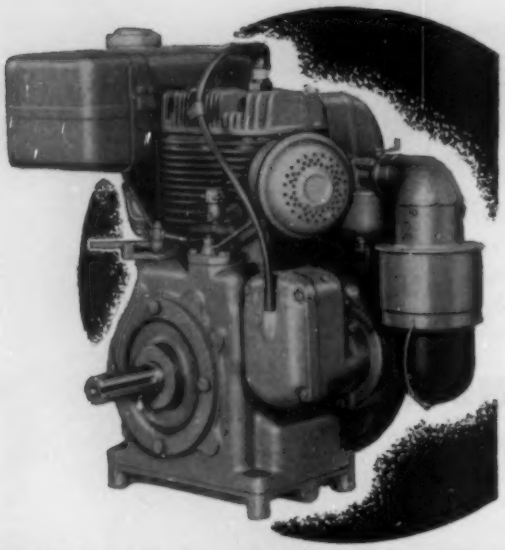
Many opportunities in the field of Precision components are open. Write for details today.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.



This is the NEW WISCONSIN

Model ACN, 5½ H.P. Single Cylinder HEAVY-DUTY *Air-Cooled* ENGINE

Here is a new, light weight engine, designed and built to Wisconsin heavy-duty standards in all details, offering original equipment builders and engine users maximum power advantage and performance in a 2.3 to 5.6 hp. range at 1600 to 3600 rpm.

Like all Wisconsin Engines, the Model ACN has the built-in Lugging Power that hangs on through the shock load pinches and keeps the job moving without stalling. With a 2⅝″ bore x 2¾″ stroke, it has a 14.88 cu. in. displacement.

Heavy-duty features include tapered roller main bearings at BOTH ends of the crankshaft; rotary type high tension OUTSIDE Magneto with Impulse Coupling for quick, all-weather starts at low cranking speed, pump-circulated splash lubrication *plus* efficient AIR-COOLING from extreme sub-zero to 140° F.

Perhaps this is just the power component you have been looking for — *power to fit the machine; power to fit the job.* Write for Bulletin S-179.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers—and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL PUBLICATIONS

Circuit diagrams of presses and hydraulic drives in machine tools provide instructive examples of typical hydraulic circuits. The book concludes with a brief survey of the use of hydraulic machinery in the fields of mining, agriculture, aeronautics, marine engines and lifting devices.

Principles of Mathematics

C. B. ALLENDOERFER, *Prof. and Executive Officer, Dept. of Mathematics, University of Washington,* and C. O. OAKLEY, *Prof. and Dept. Hd., Dept. of Mathematics, Haverford College.* 6¼ x 9 *in.*, 448 *pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $5.

Written with the conviction that large parts of standard undergraduate curriculum in mathematics are obsolete, this work takes advantage of the remarkable advances made in mathematics during the past century.

The first four chapters are an introduction to abstract mathematical reasoning and deal with logic, the number system, groups and fields. The text then presents: a treatment of sets; Boolean algebra and its application to circuit theory; a modern approach to college algebra, trigonometry, analytic geometry and calculus; statistics and probability.

Throughout the book, emphasis is placed on understanding the methods of mathematical reasoning. Routine computations are balanced with emphasis on thinking and every process is illustrated with a worked example.

Applied Thermodynamics

EARLE B. NORRIS, *Dean Emeritus, School of Engrg.,* CLARENCE E. TRENT, *Prof. of Mech. Engrg., Virginia Polytechnic Institute,* and ERIC THERKELSEN, *late Prof. of Mech. Engrg., Montana State College.* 6¼ x 9¼ *in.*, 490 *pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $7.50.

This is a new third edition and is a revision of *Heat Power*. It develops an understanding of the fundamentals of thermodynamics as applied to power generation from heat sources. The thermodynamics of each type

(Continued on page 433)

MARK-TIME
TIMING DEVICES
better
your product . . .
better your company's
profits

Mark-Time adds value to any product because it provides extra convenience and utility — with more profit to you!

PROFIT FROM MARK-TIME'S 25 YEARS OF EXPERIENCE as the world's largest exclusive designers and manufacturers of mechanical timing devices.

A SPECIALIZED ENGINEERING STAFF is ready at any time to work with you to design or adapt a timer or time control unit for your specific product.

MARK-TIME
has a TIMER
for every purpose!

MARK-TIME 25th YEAR

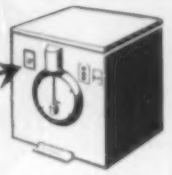
M. H. RHODES, INC.
HARTFORD 6, CONN.

MARK-TIME makes the difference!

A built-in Mark-Time automatic time switch controls this versatile cold Ultra Violet Lamp used in medical diagnosis. Only one example of how dependable Mark-Time units perform important functions on many leading brands of medical equipment.

MARK-TIME TIMERS

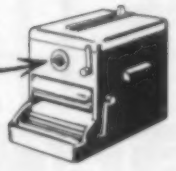
MARK-TIME makes the difference!



The fast-growing popularity of soft served frozen milk products has widened a profitable market for the manufacturers of freezer-dispensers. Mark-Time automatic time switches are widely used in these units to provide dependable accurate timing of the freezing cycle.

MARK-TIME TIMERS

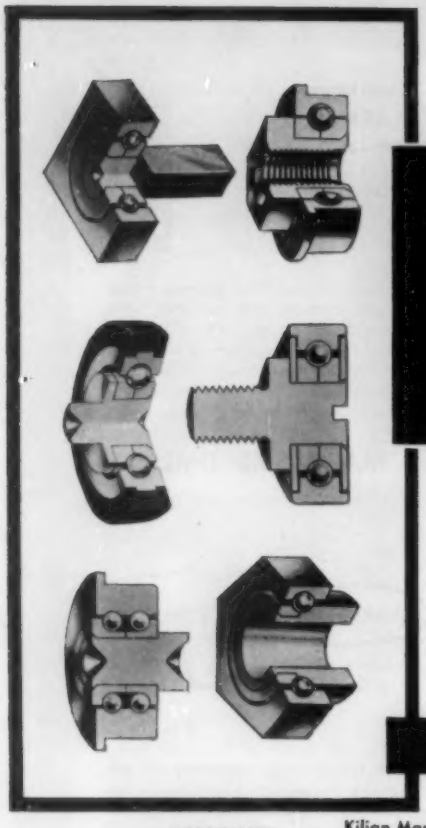
MARK-TIME makes the difference!



Built-in Mark-Time automatic time switch controls the exposure interval for a portable office copying unit which is finding wide acceptance in offices making multiple copies in less than a minute. One more example of how Mark-Time adds "sales appeal" to products for business.

MARK-TIME TIMERS

Manufactured and Sold in Canada by:
SPERRY GYROSCOPE OTTAWA Ltd., Ottawa, Ontario, Canada



UNGROUND
BALL BEARINGS
For All Industries
KILIAN

Long life and service are assured you because —
1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

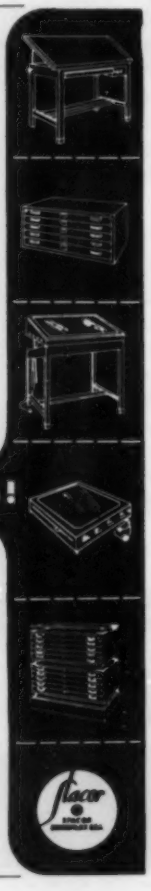
Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities — Catalog on Request

KILIAN MANUFACTURING CORP.
SYRACUSE, NEW YORK, U. S. A.

ASSOCIATED COMPANIES:
Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

4-POST DRAFTMASTER DRAFTING TABLE
in four sizes, with exclusive STACOR features that mean greater efficiency and versatility.



STACOR
LIFETIME STEEL
drafting equipment
ENGINEERED for your job!

Expertly designed steel equipment of finest quality is a lifetime investment in drafting room efficiency. The Stacor line of modern, functional drafting tables, tracing tables, and blue print filing cabinets have proven acceptance among engineers, draftsmen and architects everywhere!

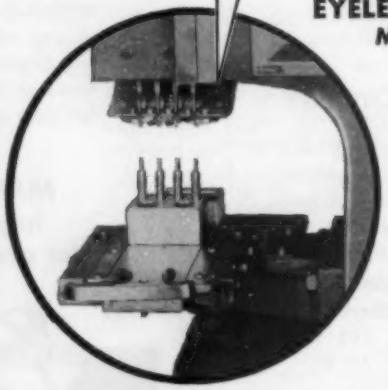
WRITE FOR YOUR COPY OF THE STACOR CATALOG TODAY!

STACOR EQUIPMENT CO.
788 East New York Avenue, Brooklyn 3, N. Y.

IF YOUR ASSEMBLY REQUIRES MORE THAN ONE EYELET...

Eliminate those extra handling operations!

Edward Segal
AUTOMATIC EYELET ATTACHING MACHINERY



You'll be surprised at how inexpensively you can obtain Edward Segal machinery for multiple eyelet setting, and how it slashes production time and costs... Used in hundreds of plants in diversified industry wherever eyeleting is called for.

Submit your specs for analysis today, and write us for our interesting booklet loaded with eyelet setting data, #30

EDWARD SEGAL • 72 SPRING STREET, NEW YORK 12, N. Y.
Eyeleting machinery, special hoppers & feeding devices

heat engine are developed after a thorough introduction to the mechanical principles underlying the machine.

The text is divided into three phases. First, a thermodynamic study of the internal combustion engine including spark ignition, compression ignition, reciprocating engines, and the gas turbine; second, steam power generating plants, accessories, auxiliaries, dust collectors, and various types of steam engines; and last, compressors and refrigeration equipment.

Among the new developments presented are dual-fuel diesel engines; gas turbines for stationary and locomotive power and jet propulsion; nuclear power as a development of the future; and a chapter on displacement and kinetic type compressors. Many of the problems have been revised and the appendix has been enlarged.

Helical Spring Tables

JOHN D. GAYER and PAUL H. STONE, JR. 6 x 9 in., 165 pp. *Published by Industrial Press, 93 Worth St., New York 13, N. Y.* $5.

This is a compilation of 6800 ready-designed compression and tension springs from which selection can be made to meet specific design requirements. Tables of compression springs cover coil diameters from $\frac{1}{8}$ to 4 in. Tables of tension springs include coil diameters from $\frac{1}{8}$ to 2 in. Data in the tables are based on spring steel wire and service life of 20,000 cycle at full range deflection.

Also included are instructions for using the tables: (1) to establish an approximate set of specifications; (2) for service life other than 20,000 cycle; and (3) to select springs for other than full range deflection.

Analytic Geometry

Ross R. MIDDLEMISS, *Prof. of Mathematics, Washington Univ.* 6 x 9 *in.*, 310 *pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y.* $3.75.

Since the majority of those studying analytic geometry are preparing for a study of calculus, more emphasis is placed on graphs and properties of polynomials, and on rational, exponential and trigonometric functions

(Continued on page 435)

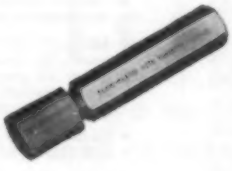
FLP SERVICE MARK Design NEWS

News of Another Design Problem Solved With Flame-Plated Tungsten Carbide Coatings.

Aluminum Forging

Shaft Seal

Gripping Dog


Plug Gage

Bushing

Turbine Rotor

Here are a few highly successful Flame-Plating applications. Perhaps Flame-Plating can help you solve design problems on similar parts.

Flame-Plating proves

"Two metals are better than one"

Many times two metals are better than one especially when you can combine the wear-resistance of tungsten carbide with the metallurgical advantages of most any other metal. For example, by Flame-Plating a thin coating of tungsten carbide on aluminum, magnesium, or titanium, you can combine wear-resistance with light weight and low moment of inertia. Undoubtedly, you can think of many other combinations that would help you solve your design problems.

Flame-Plating is LINDE's service, performed in LINDE's plants, for depositing a thin coating of tungsten carbide on metal parts. Finished or semi-finished parts can be Flame-Plated without distortion for the temperature of the part being plated seldom reaches 400 deg. Fahrenheit. The coating may be used in as-coated condition (similar to fine emery paper) or finished to fine tolerances for precision applications.

For the full Flame-Plating story, call your nearest LINDE Office or write for your free copy of the Flame-Plating booklet.

design with Flame-Plating in mind

LINDE AIR PRODUCTS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y. UCC Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto

Linde Trade-Mark

"Linde" is a trade-mark and "FLP" is a service mark of UCC.

ALCOA
UTILITUBE
saves up to
40%
over copper

coiled
aluminum tube
readily available for
lubricating lines, fuel lines,
air lines, hydraulic fluid lines

ALCOA® Utilitube offers savings up to 40% over copper tube. Made of a special ALCOA alloy, ALCOA Utilitube work-hardens less, has excellent flaring and forming characteristics, stands up well under vibration.

ALCOA Utilitube will not cause sludge or gum formations . . . will not contaminate the fluids it carries. Its light weight makes economical long lengths —up to 1,000 feet—easier to handle.

For more information on this versatile product, write today for the FREE booklet, *Alcoa Utilitube*. Contains complete information on how to put this money-saving tube to work for you.

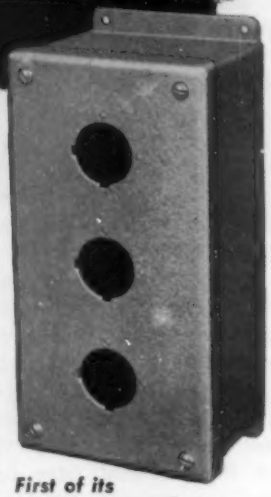
Your ALCOA distributor carries abundant supplies of ALCOA Utilitube in stock, and fittings are readily available from several manufacturers.

ALCOA
ALUMINUM
ALUMINUM COMPANY OF AMERICA

ALUMINUM COMPANY OF AMERICA
909-L Alcoa Building, Pittsburgh 19, Pennsylvania

BRAND NEW! WELDED SHEET STEEL CONSTRUCTION

OIL-TIGHT
PUSH BUTTON
ENCLOSURES



Immediately available in ten standard sizes to accommodate from one to twenty-five push buttons.

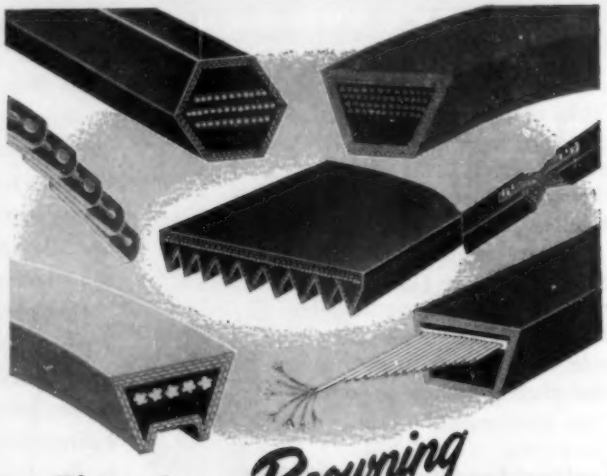
- Patented push button openings will fit all standard makes of oil-tight units.
- Conduit connections may be made at any location you specify.
- Absolutely oil tight, water tight, dust proof. No knockouts or holes in this heavy 14 gauge sheet steel box. All seams welded. Mounting feet are externally attached.
- Neoprene sponge gasket provides positive cover seal.
- Unique sliding hinge will hold cover in open position if desired. Cover screws are captivated. They thread into closed-end steel "Rivnuts" located in box flange. Cannot leak.

First of its kind on the market!

- Pendant type, flush cover type and other special enclosures also fabricated.
- Painted attractive gray hammertone enamel.
- REASONABLY PRICED!

For full details write Dept. PE-41

Hoffman ENGINEERING CORPORATION
ANOKA, MINNESOTA



There's a Browning GRIPBELT
for every purpose!

No other source offers such a wide selection of V-belts . . . from FHP to steel cable belts, including versatile Griplink and Griproll, and unique new Poly-V. These combine with Browning's variety of sheaves to form the most complete V-drive line. For every power transmission need, contact your Browning distributor. He will serve you promptly, efficiently. *Write for free catalog GC101, showing whole line.*

Browning MANUFACTURING COMPANY
MAYSVILLE, KENTUCKY

than on the classical study of conic sections. Following a brief review of basic facts and formulas of algebra and trigonometry are 13 chapters on plane analytical geometry and three chapters on solid analytical geometry. Throughout the book the author seeks to develop the reader's general mathematical training as well as presenting the methods and formulas of the subject.

In this second edition new problems, new figures, new illustrative examples, and sometimes a new point of view have been introduced as a result of the author's experience in using the first edition. This treatment will make a substantial contribution toward a better understanding of the role of definitions and in forming the habit of reasoning carefully from hypothesis to conclusion.

Basic Engineering Mechanics And Machine Design

S. S. AIDLIN, 8½ x 11 *in.*, paper-bound, 92 pp. *Published by Pelex Publishers, Inc., 95 Liberty St., New York 6, N. Y.* $3.

This review of statics, dynamics and elementary machine design was developed as an aid in preparing for the Engineering License Examination in New York State.

It consists of three parts: brief review of theory, problems from past examinations, and solutions to these problems.

Reference Tables For Thermocouples

NBS Circular 561, HENRY SHENKER, JOHN I. LURITZEN, JR., ROBERT J. CORRUCCINI *and* S. T. LONBERGER. 10¼ x 7¾ *in.*, 84 pp. *Published by the U. S. Government Printing Office, Washington 25, D. C.* $0.50.

This reference book supercedes Circular 508 and gives expanded tables for platinum-platinum-10 per cent rhodium; platinum-platinum-13 per cent rhodium; chromel-alumel; iron-constantan (modified 1913); copper-constantan; and chromel-constantan thermocouples with temperature in degrees C and F and electromotive force (emf) in millivolts. The tables

(Continued on page 437)

Would a superior coil spring solve your design problem?

I-S BeCu Springs have an impressive record of superior performance

- ★ *High strength*
- ★ *High Conductivity*
- ★ *Uniformity*
- ★ *Reduced set and drift*
- ★ *Close tolerances*
- ★ *Long endurance life*
- ★ *Corrosion resistance*
- ★ *Stability at extreme temperatures*
- ★ *Reduced inspection and assembly costs*
- ★ *Reduced space requirements*

It is known that beryllium copper does have certain inherent advantages for some applications. But I-S exclusive heat-treating techniques in spring-forming have magnified and multiplied these advantages. From jet aircraft to refrigerators, billions of I-S BeCu springs have been used for their superior performance—and the resulting economies in cost and labor.

Call it difficult? Then call I-S . . .

From design conference—to prototype—to finished production . . . I-S' exclusive facilities and the specialized ability of our engineering staff are available to help solve your challenging problems.

For more information on BeCu Springs, write today for your free copy of our newest catalog, No 8. For electronic components, ask for No. 8-A.

Like many other leading manufacturers, you will find that these I-S facilities can make significant improvements in your manufacturing processes, and in your product. And they most likely will save you money. One thing is certain . . . it costs nothing to compare.

But it may cost considerable, not to!

Instrument Specialties CO. Inc.

234 BERGEN BOULEVARD, LITTLE FALLS, NEW JERSEY

Telephone Little Falls 4-0280

do you have an

imagineering **department?**

Take a good look at your product!
Now take a good look at some of the outstanding features of a POWER PRODUCTS 2-cycle engine!

● **LIGHTWEIGHT** — 60% lighter than most ordinary engines of equal horsepower. You can redesign for greater portability.

● **EXTREME TILTABILITY** — perfect performance at any angle — no oil to spill out, no lubrication problem — no need to be saddled to a single position.

Imagine what this POWER PRODUCTS 2-cycle Lightweight Engine can do for your products!

It opens many new product ideas to imaginative engineers looking toward tomorrow's portable equipment. Write today for full information.

POWER PRODUCTS
CORPORATION
GRAFTON, WISCONSIN

World's Largest Builders of small 2-cycle industrial engines

MAYLINE

5 DRAWER UNIT
WITH CAP AND BASE

A Feature of the MAYLINE Metal Plan File

Mayline drawers lock into position when open. Hinged dust cover frees hands for filing or removing prints. Ask your local dealer to show you this feature.

PLAN FILE
WITH HINGED DUST COVER

5 DRAWER UNITS STACKED

Symbol of MAYLINE Superiority

MAYLINE CO.
605 No. Commerce St.
Sheboygan, Wisconsin

MAYLINE

SOLVE RETAINING PROBLEMS with

SpirOlox

Retaining Rings

With Spirolox you are assured of quick, easy installation and removal of the retaining ring. As illustrated by this installation on a tube-cutter assembly, Spirolox is inserted in a jiffy, removed with a flip of a screwdriver. No special tools needed.

Simplified, trouble-free solutions to retaining problems like this are possible because of extraordinary Spirolox flexibility and conformability. Unique two-turn construction lets you spiral-in a Spirolox ring quickly and easily. Complete elimination of lugs or projections, breaks or gaps, provides uniform shoulder which conforms 100% to diameter of groove.

SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS

FREE DATA BULLETIN tells how you can solve toughest retaining problems with SPIROLOX—send for your copy! Ramsey Corporation, St. Louis 8, Missouri, 108-R

U. S. Pat. No. 2,450,425 and Foreign Pats. Other Pats. Pend.

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

are based upon the absolute electrical units and the International Temperature Scale of 1948.

These temperature emf tables for thermocouples can be used to convert measured emf into equivalent temperatures, for testing and calibration of commercial thermocouples, for the preparation of purchase specifications for thermocouple wire, and in precise calibration of instrument scales in order that temperatures may be read directly.

Vapor-Plating

C. F. POWELL, I. E. CAMPBELL and B. W. GONSER, *Battelle Memorial Institute, Columbus, Ohio.* 6 x 9¼ *in.*, 158 *pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $5.50.

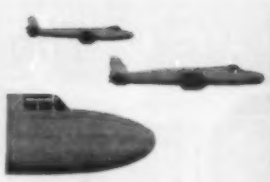
This book is a well-written review of the applications and techniques of vapor deposition of metals and nonmetals. It is an excellent single source of information and reference on these processes. The extensive experience of the authors, all members of the staff at Battelle Memorial Institute, is reflected in their evaluation and presensation of the data.

The book provides a complete description of present and past applications of vapor deposition techniques, including many which are not widely known. Vapor-plating is a chemical process where the metal is transported as a compound from which the metal is obtained by a chemical reaction (usually thermal decomposition or hydrogen reduction) at the sample surface which is hotter than the source of the metal-containing vapor.

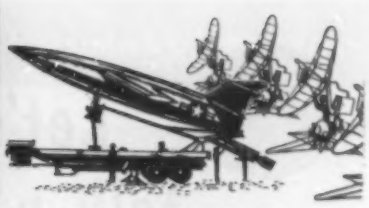
Chemical vapor-plating came into prominence about 1925 when it was extensively investigated as a method for preparing high-purity metals. Its use to produce coatings was stimulated when the need for new refractory coatings became urgent during World War II.

The book describes the general techniques employed in vapor-plating and discusses the conditions required for the deposition of pure metals, carbides, nitrides, borides, silicides, and oxides from gaseous mixtures of their vaporized compounds. Detailed kinetic and thermodynamic studies have been carried out for only a few vapor-deposi-

(Continued on page 439)

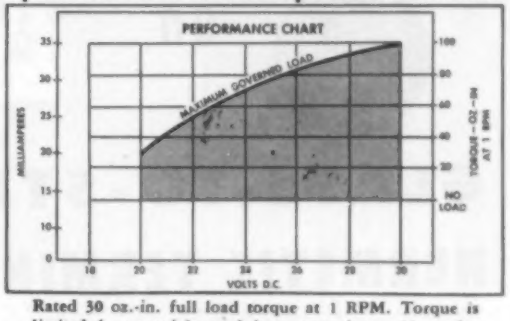


they shall not pass!



A. W. HAYDON PRECISION GOVERNED 5600 SERIES MOTOR insures performance of America's perimeter defenses.

5600 Series GOVERNED D. C. MOTOR



SPECIFICATIONS
1. Voltage range nominal ± 20% at 68°F.
2. Ambient temp. range minus 65°F to plus 165°F.
3. Vibration 5-55 cycles per sec. with 10g max. accel.
4. Tolerance on escapement rate:
   (a) ± 0.1% under condition 1
   (b) ± 0.3% under condition 2
   (c) ± 0.5% under condition 3
5. Shock — per MIL-E-5272A, Proc. 1 (30g for 11ms)

Rated 30 oz.-in. full load torque at 1 RPM. Torque is limited by materials used in gear train to 20 oz.-in. intermittent or 5 oz.-in. continuous duty at 1 RPM. Special gear trains are available.
Output speeds from 900 RPM down to 1 revolution in 2 hours can be provided.

WHEN TIMING POSES A PROBLEM CONSULT . . . .

(General Catalog Sent on Request)

The A. W. HAYDON COMPANY
221 NORTH ELM STREET
WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

Another of the Reasons Behind Brad Foote Quality—

DEBURRING

• Deburring of gears isn't normally included in specs or drawings. And we don't get paid for it. But here at BRAD FOOTE we take pains and expend many man hours on deburring—for we know that one tiny burr can ruin a $100,000 machine.

• Examine your next shipment of gears. See whether your present supplier is painstakingly removing all the burrs. Find out how many hours your assembly department has had to charge against deburring. See another way in which BRAD FOOTE quality and extra attention to details saves you money.

• Prove to yourself the savings that BRAD FOOTE quality can mean. Let us quote on the gear requirements for your next program—whether it be radar equipment, diesel engines, etc. BRAD FOOTE has experience in providing gears for almost every specialized application and would welcome the opportunity of discussing your gear problems.

BRAD FOOTE MAKES ALL TYPES OF GEARS—
IN A COMPLETE RANGE OF STYLES AND SIZES

BRAD FOOTE GEAR WORKS, INC.
1309 South Cicero Avenue • Cicero 50, Illinois
Bishop 2-1070 • OLympic 2-7700 • TWX CIC-2856-U

subsidiaries
AMERICAN GEAR & MFG. CO.
Lemont, Illinois Phone Lemont 920
PITTSBURGH GEAR COMPANY
Phone SPalding 1-4600 Pittsburgh 23, Penn.

Let's talk price on

GLASS-TO-STEEL HERMETIC TERMINALS

Since the day Fusite started business we've planned, worked and talked quality. The price of Fusite Terminals has always been set by what it cost to produce them plus a reasonable profit.

The very same policy is in effect as we adopt a new price structure that lowers prices by as much as 35% on some models.

Our greatly increased volume of business, has so cut our costs that we are able to make satisfactory profits on reduced prices with quality hitting new highs.

If yours is one of those companies which have felt Fusite quality was a luxury you could not afford—that our terminals were better than you had to have, we'll be happy to quote today. You'll be happy, too.

Write Department Q-3

FUSITE TERMINALS

THE FUSITE CORPORATION
6026 FERNVIEW AVENUE
CINCINNATI 13, OHIO

The New Improved *Fluid Feed* ROTARY TABLE

Deftly holds and delivers small parts to drill, tap, swage, stake, etc. 8, 12 or 24 stations accurate to .003". Positive, uniform air-hydraulic indexing—not a mere hydraulic check. Indexes slow or fast, up to 2800 per hour. Compact and sturdy, easy to tool and hook up. Standard dial plate 12" x ½" ground steel. For a new job, simply tool up a new dial. Readily combines with "MEADMATIC" Timer, Air Hammer, Air Press, Drill Presses, etc.—to make almost completely automatic machines—operator merely loads.

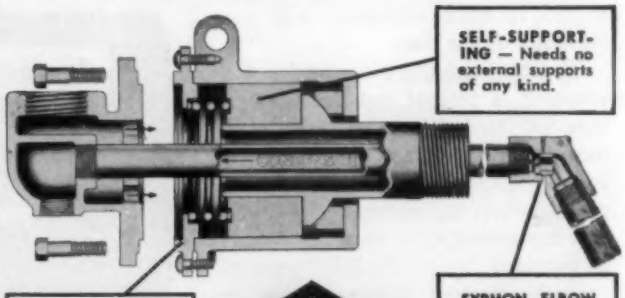
Send for new Air Power catalog today!

(See Volume III Thomas' Register for nearest distributor's address, phone number.)

MEAD SPECIALTIES COMPANY

4114 N. Knox Ave., Dept. PE-115, Chicago 41, Ill.

PATHFINDER IN AIR POWER AUTOMATION


SELF-SUPPORTING — Needs no external supports of any kind.
ASSEMBLY PLATE — Holds internal parts in position when head is removed.
SYPHON ELBOW — Permits use of straight pipe for syphon. Can be inserted or withdrawn right through the joint.

Johnson Rotary Joint with SYPHON ELBOW

Johnson Joints represent the best way industry has yet found to get steam or liquids into rotating rolls and cylinders. They are completely packless, need no lubrication or adjustment. The Type SBP shown gets steam in, condensate out, through the same head. Other types available for through flow service, in sizes to meet all operating needs. ***WRITE FOR COMPLETE INFORMATION.***

The Johnson Corporation

813 Wood St., Three Rivers, Mich.

tion reactions such as those involved in industrial chromizing and siliconizing processes.

In addition to a summary of the properties of many of the resulting coatings and materials, new applications for the processes are suggested. Literature references are cited at the end of each chapter.

Dielectric Behavior and Structure

CHARLES PHELPS SMYTH, *Prof. of Chem., Princeton University.* 6¼ x 9¼ *in., 441 pp. Published by the McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.* $9.

This book is outstanding in the chemistry, physics and engineering of insulators of all types. It explains the relations between the molecular structure of matter and the dielectric behavior of matter, also the use of experimental measurements of dielectric constant and loss and electric dipole moment in the investigations of the nature of molecular structure of liquids and solids.

The first half of the book discusses basic theories of dielectrics, interpretation of dielectric constant and loss data in terms of structure, and the actual methods of measurement. Experimental results on many liquids and solids are discussed in detail. Separate sections are devoted to glasses, high polymers, ferro-electrics and electrets.

The latter half is the most extensive available account of use of the dipole moment in determination of molecular structure, study of the nature of chemical bonds, resonance and intramolecular energy.

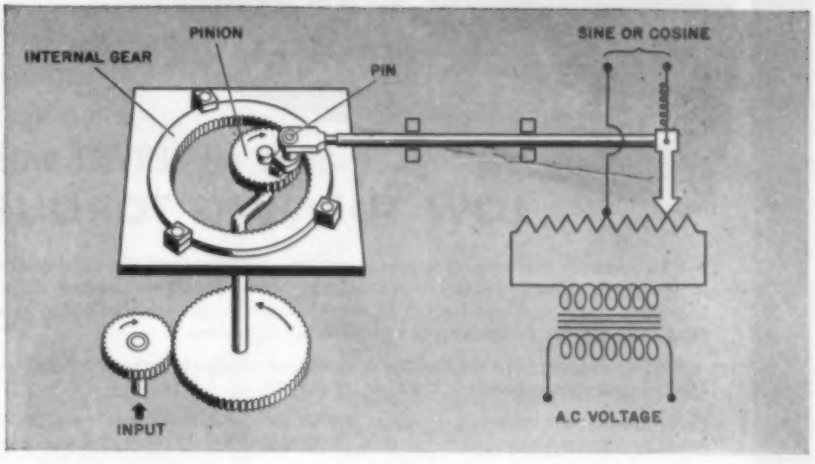
Chromium Plating

PAUL MORISSET, *Directeur du Centre d'Information du Chrome Dur, Paris, France;* J. W. OSWALD, *Ch. Chemist, Fescol Ltd.;* C. R. DRAPER, *Editor* and R. PINNER, *Asst. Editor, Electroplating.* 5½ x 8¾ *in., 611 pp. Published by Robert Draper Ltd., 83/85 Udney Park Road, Teddington, Middlesex, England.* $11.

This is a text book which provides a good, comprehensive coverage of the subject. The work is divided into six major parts, an appendix and an alpha-

(Continued on page 441)

SINCE 1915 LEADERS IN AUTOMATIC CONTROL



Ingenious electro-mechanical device generates sine or cosine function

From a combination of mechanical and electrical principles, Ford Instrument Company engineers have produced and patented an electro-mechanical device to generate sine and cosine functions. The mechanical portion is an internal-gear angle resolver. It consists of two gears — an internal gear and a pinion. Because the pinion has exactly half the number of teeth as the internal gear, the pin on its pitch circle traces a straight line when the pinion rolls inside the angle gear.

Furthermore, the displacement of the pin relative to the center of the internal gear is proportional to the sine (or cosine) of the roll angle of the pinion.

If a linear potentiometer is now placed along the diameter of the internal gear and a potentiometer slider is fastened to the pin on the pinion, the voltage picked off by the brush is proportional to the sine (or cosine) of the angle.

Two such systems, connected in tandem, produce simultaneously both the sine and cosine functions.

This is another example of Ford Instrument engineering ingenuity. What appears on the surface to be a complex problem is solved by the combination of well-known principles.

Perhaps you have a problem that could benefit from Ford Instrument experience. Ford Instrument engineers work every day with systems using mechanics, electronics, hydraulics, electro-mechanics, magnetics, atomics. How can Ford help you?

79

FORD INSTRUMENT COMPANY
DIVISION OF SPERRY RAND CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

ENGINEERS
of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information.

REPUBLIC "LO-TORQ" SELECTOR VALVE

0-6000 psi SERVICE with LOW TURNING TORQUE

Exceptionally low turning torque is obtained by "floating" the valving disk in the service fluid, thereby balancing the pressure and eliminating thrust bearings . . . a sound application of the hydraulic engineering principle that fluids under pressure exert force equally in all directions.

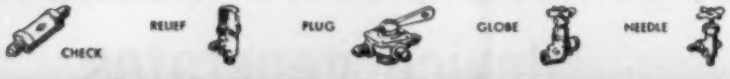
Sealing rings on both sides of the selector disk eliminate leakage at all times whether pressure is forward, back, or off entirely.

For air and gas service, 0-2000 and 0-4000 psi; for fuel, hydraulic oil, petroleum, and water service, sizes ⅛" to 1", 0-3000 and 0-6000 psi. 2, 3, and 4-way.

Write for catalog no. 454 for complete information.

Distributors in principal cities from coast to coast.

- 0-6000 psi service
- Low turning torque
- Panel mounting
- Semi-steel, bronze, aluminum alloy
- No leakage at any time
- 3 types of portings



130

RM

REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

FOR Quality Performance from
WIRE FORMS
SPRINGS
METAL STAMPINGS
Rely on
DUDEK & BOCK
You get precision WIRE FORMS, Springs and Stampings that are easily assembled . . . that withstand stresses . . . perform under the most *trying* conditions. Rely on our free designing service. Our EXPERT ENGINEERS will produce design that meet your *exact* needs—and save you MONEY!
Valuable FREE Brochure
SPEEDY DELIVERY
WRITE—WIRE or PHONE
for Estimates and Delivery Dates
DUDEK & BOCK
SPRING MFG. CO.
Phone:
DICKENS 2-1020
4014 W. Grand, Chicago 51, Ill.

IF THIS IS YOUR PROBLEM

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, train employees, and perform any of the other communicative functions that are vital to your business . . .

THIS IS YOUR ANSWER

The McGraw-Hill TECHNICAL WRITING SERVICE has a staff of more than 150 highly-trained writers, editors, and illustration specialists whose job it is to create technical and general literature for industry. We write, illustrate, design, and print Equipment Manuals, Product Bulletins, Handbooks, Company Histories, Annual Reports, and other specialized material. Save money and time. Let our staff be your staff for Technical and Business publications.

This service is available through ad agencies.

Write • Phone

TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

betically arranged list of more than 400 references, to December, 1953.

Part I, a discussion of the theoretical aspects of chromium electrodeposition includes chapters on the mechanism of the process, solutions for chromium plating, electrode reactions, effect of variations in operating conditions, and cathode efficiency. Other chapters in this part describe the conductivity of chromium plating solutions, throwing power, rate of deposition, anode reactions and the influence of cathode characteristics.

Part II presents a complete description of the technique of hard chromium plating while Part III is concerned with the properties of hard chrome deposits. The industrial applications of hard chrome plating are enumerated and explored in Part IV. Decorative chromium plating is covered in Part V.

The last section of the text, Part VI, is made up of miscellaneous chapters discussing such items as control of chromium plating solutions, the cost of chrome plating, health hazards and the disposal of chrome wastes.

This book is the third of a series of reference works on electrodeposition and related subjects. The other two books are "Analysis of Electroplating and Related Solutions" by K. E. Langford, and "The Filtration and Pumping of Plating Solutions" by G. T. Colegate.

Calculation of Change Gear Ratios

ERIC H. WANG, 8½ x 11 *in., paperbound, 116 pp. Available from Eric H. Wang, 601 Monroe Drive, Xenia, Ohio.* $3.50.

The author has developed a method of calculating gear ratios that approach a desired value, expressed in the form of a decimal, which is said to enable one to find more usable ratios in a shorter time than is possible with any other known system.

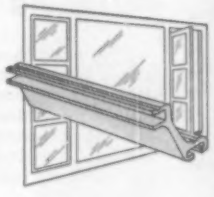
Requiring the factor tables and charts that make up the bulk of the book, this method also is said to have these additional advantages:

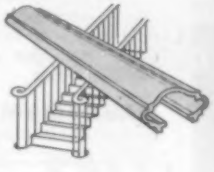
1. No calculating machines are necessary, although they can be used to advantage if they are available.

2. All the mathematical knowledge necessary, after the desired ratio is

(Continued on page 443)

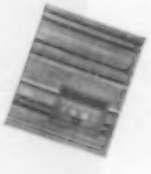
HOW PE "CREATIVE EXTRUSIONEERING"
CAN HELP YOU CUT MANUFACTURING COSTS
... IMPROVE PRODUCT QUALITY





PE's Creative "Extrusioneering" is more than just a designing and mill service. It's an expanded assistance program designed to help you create new aluminum extrusion applications for your product ... applications that will cut manufacturing costs and improve product quality. Because PE's staff of competent engineers have wide experience in all types of fabricating operations, they can provide invaluable aid in helping develop ideas that will, for example, reduce fabricating costs, simplify assembly, eliminate machining operations, and provide greater stability and strength. Why not call in a PE engineer without obligation and let him analyze your product for possible cost-cutting extrusion applications. PE aluminum extrusions are produced under the latest methods of scientific quality control ... facilities are complete from billet casting to finished extrusion. PE specializes in the job of PRODUCING EXTRUSIONS ONLY ... they do not fabricate, they do not manufacture any other product. Your inquiries receive personalized and confidential attention.

FREE 12-PAGE BULLETIN
Write today for free technical bulletin illustrating and describing PE services and advantages of the aluminum extrusion process.



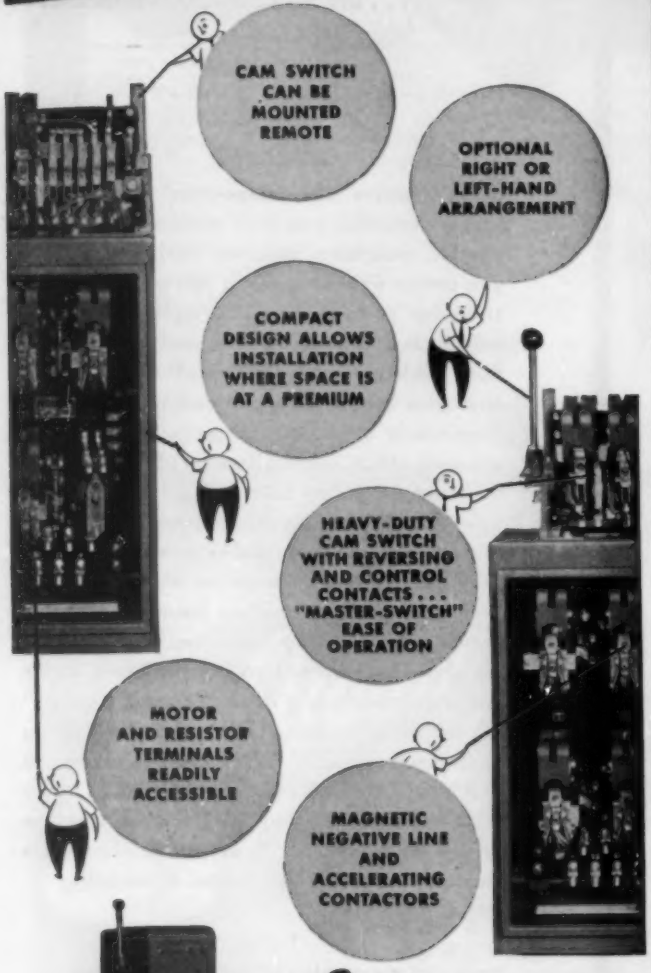
Chicagoland's Oldest Aluminum Extruder

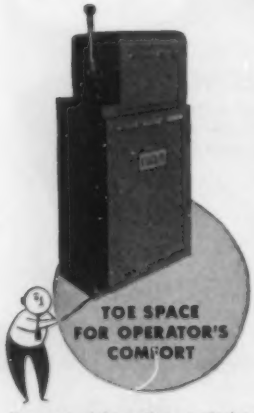
PRECISION PE EXTRUSIONS
729 GREEN AVENUE BENSENVILLE, ILLINOIS
Phone: Bensenville 98 Chicago TUxedo 9-1701

NEW

HEAVY-DUTY D-C MAN-NETIC CONTROLLERS*

COMBINATION MANUAL and MAGNETIC CONTROLLER FOR CRANES—CHARGING MACHINES—D-C CONTROL JOBS


CAM SWITCH CAN BE MOUNTED REMOTE
OPTIONAL RIGHT OR LEFT-HAND ARRANGEMENT
COMPACT DESIGN ALLOWS INSTALLATION WHERE SPACE IS AT A PREMIUM
HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
MOTOR AND RESISTOR TERMINALS READILY ACCESSIBLE
MAGNETIC NEGATIVE LINE AND ACCELERATING CONTACTORS



2 TYPES AVAILABLE: REVERSE-PLUGGING OR DYNAMIC - LOWERING

Provide four speed points, reversing, with all advantages of full-magnetic control. Manually-operated cam contacts are free of destructive arcing . . . extremely fast magnetic contactor action interrupts power circuit before cam-operated contacts are opened. EUCLID'S EXCLUSIVE "TIMELOK" feature offers maximum dependable acceleration timing without extra relays . . . permits unusually compact arrangement of the magnetic panel.

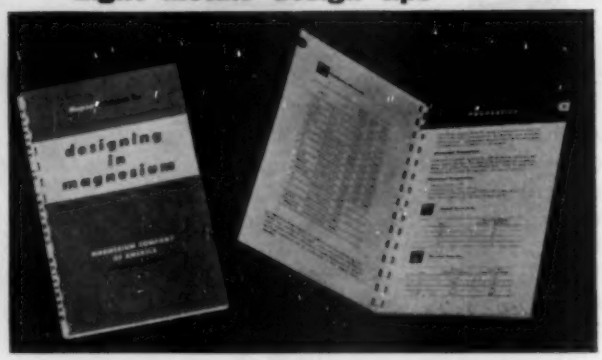
For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.
Ask for Bulletin 4400-4401.

*PATENT APPLIED FOR.

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG CO., MADISON, OHIO

Light metals design tips



Free new handbook of helpful data for designing in magnesium

This new handbook—complete with tables and graphs—will answer many of your questions about designing structural assemblies of magnesium. There are complete sections on design, properties, metal working, surface treatment, assembly, and other related subjects.

You'll find helpful data on working stresses, bend radii, spotwelding, shear strengths, riveting, machining and bolting.

Copies are available without charge while the limited supply lasts.

And remember, whenever light metals can be used for your parts or products, Magcoa engineers can help you design them and Magcoa fabricating facilities can produce them for you.

MAGNESIUM COMPANY OF AMERICA
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.

magcoa

Why SCHNORR Disc Springs?

BECAUSE

1. Unlimited life within borders of permissible loads
2. No creeping, initial settling or gradual fatigue.
3. Axial center pressure.
4. Exact adjustment to the desired pressure.
5. Small constructional height, large deflection.
6. Large inherent damping.
7. Large impact damping especially with multiple stacking.
8. Excellent space disposition.
9. Spring pressure, Spring length and Spring deflection can be easily determined for the same Spring size or can be changed by lengthening or shortening of the Spring columns or by multiple stacking. In special cases the character line can be made to divert from its usual form by diversified stacking.
10. Most Spring sizes available from stock.

For Descriptive Literature Write

KARL A. NEISE, Dept PE
404 Fourth Avenue, New York 16, N. Y.

There are hundreds of applications for

Electronics	✓
Appliances	✓
Instruments	✓
Commutators	✓
Heating Elements	✓
Insulation	✓
Resistors • Tubes	✓
Capacitors • Coils	✓
Switches • Fuse Plugs	✓

SAUEREISEN CEMENTS

Speed assembly, improve quality and save time and money. Write for catalog.

TRIAL ORDER

A complete electrical cements laboratory at your fingertips—for experimental work. One-quart can each of 14 different cements for only . . . **$12.50**

Sauereisen Cements Company • Pittsburgh 15, Pa.

presented in the form of a decimal, is confined to elementary operations like addition, subtraction, multiplication and division of whole numbers and decimals; and extension, reduction and cancellation of a fraction without changing its value.

3. No knowledge of logarithms or other advanced mathematics is required.

5. Error made can easily and closely be estimated at a glance without resorting to longhand, machine, slide rule or logarithmic calculations.

6. Method must lead to a suitable result, if there is one within the defined limits, by simply following through. There is no necessity for starting anew with other assumptions if a certain chain of possibilities is exhausted, or of changing the design (helix angle) of the gear to be produced as some people do.

7. No calculations are necessary to determine whether one is still within the desired limits or not.

7. It is possible, in a very short time, to find enough gear ratios to enable the calculator to choose from them the most convenient ones. For example, one which makes possible the use of gears in stock or the one that gives a ratio closest to the wanted ratio, or both conditions combined.

8. It takes only a few hours, even for the inexperienced, to learn how to apply this method.

9. Can be used to improve gear ratios as well as to find ratios to satisfy a given value.

Industrial Automatic Controls

MILLARD H. LAJOY, *Assoc. Prof. of Mechanical Engineering, Univ. of Minn.* 8½ x 5¾ *in.*, 278 *pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York* 11, *N. Y.* $6.65.

This book is a fundamental text in automatic control systems and is based upon more than eight years of teaching the subject. The result is a book which accomplishes its objective in admirable fashion; it is recommended for independent study by mechanical or electrical engineers who wish to acquire a basic knowledge of the field with a minimum of effort. Throughout the book the various phases of automatic control are presented in a lucid manner with a mini-

(Continued on page 445)

MIDLAND
WELDING NUTS
...Make Tough Jobs Easy!

SAVE TIME!
SAVE TROUBLE!
SAVE MONEY!

If you've got a product involving metal fabricating, fastening or assembling, chances are you can use Midland Welding Nuts to big advantage.

They come in all sizes for every-sized job. Welded to the part or parts concerned, they don't have to be held while bolts are turned into them. Thus one man can often do the work of two.

And they're indispensable when it comes to those tucked away, hard-to-get-at places. Welded in advance to those inside spots where it is difficult—or *impossible*—for hands or tools to reach, Midland Welding Nuts hold fast while bolts are turned into them.

If you're a designer, you'll want to know about these time and labor-savers, too. Midland Welding Nuts will solve and simplify many of *your* problems, too.

Write or phone for complete information!

The MIDLAND STEEL PRODUCTS COMPANY
6660 Mt. Elliott Avenue • Detroit 11, Michigan
Export Department: 38 Pearl St., New York, N. Y.
Manufacturers of
Automobile and Truck Frames • Air and Vacuum Power Brakes
Air and Electro-Pneumatic Door Controls

...EXAMINE THIS HOSE COUPLER...

will it help YOU?

HOOK... PUSH... ...CLICK

Instant Free Flow

NEW

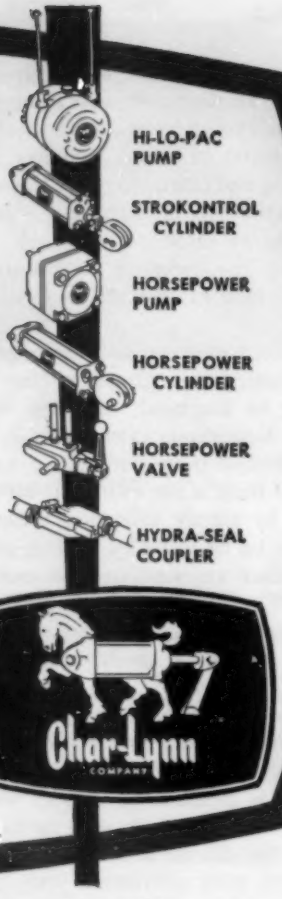
Char-Lynn

HYDRA-SEAL HOSE COUPLER

The Char-Lynn Hydra-Seal Hose Coupler has been engineered and designed as a quick-connect self-sealing, break-away coupler for all fluid carrying hoses.

Operation of the Hydra-Seal Coupler is as simple as inserting or removing a plug from an electrical outlet. To couple, hook on and push together; to uncouple, pull apart; no tools are needed. As the barrels are hooked over the slide lugs and the coupler pushed together, the barrels displace the slides and the barrel ports are brought into register or alignment . . . thus allowing the free flow of fluid through the coupler. Pulling the coupler apart brings the slides into position over the ports—oil is sealed in, dirt sealed out.

Let Char-Lynn solve your coupler problems.



CHAR-LYNN COMPANY

Dept. PE-11 2843-26th Avenue South, Minneapolis 6, Minnesota

Member — National Fluid Power Association

FOR HIGH THERMAL RESISTANCE

SPECIFY UNIVERSAL

Gray Body Porcelain Insulators

This gray body mogul base adds a safety factor to performance by its heat resisting, non-charring qualities. Wherever heat may generate especially at electrical connections, contactors or terminals, follow the safest design practice by specifying Universal Porcelain Insulators.

If you have an insulator problem, send your specs to Universal. We'll help you develop the right insulator to improve your product's performance, and service life.

THE UNIVERSAL CLAY PRODUCTS CO.

1545 EAST FIRST STREET SANDUSKY, OHIO

TRADE MARK

CLOSE UP OF TYPE V-1 CADDY TOGGLE CLAMP

CADDY Toggle Clamps are used on the FORD Cleveland Foundry core wash operation in the manufacturing of FORD and MERCURY engine castings.

The FORD Foundry turns out castings for both FORD Engine Plants in Cleveland and high production equipment is essential.

Prior to the adoption of the CADDY Toggle Clamps, FORD tested the clamps for 6 months. The key feature in the selection of CADDY was that they maintained uniform clamping pressure throughout the life of the clamp and developed no springing or wobble.

CATALOG ON REQUEST

CADDY TOGGLE CLAMPS

Erico Products, Inc.

2070 E. 61st Place • Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 3871 Dundas St., West, Toronto 9, Ontario

mum of simple differential equations describing dynamic response of various types of control.

Chapter 1 presents elementary examples of the transition from manual to automatic control in terms of closed-loop systems. Four basic modes of automatic control — on-off, proportional, integral (floating), and derivative (rate) are discussed in Chapters 2, 3, 4 and 5. Control effects are given a thorough analysis, and controller output characteristics for various input disturbances are shown graphically. Chapter 6 is devoted to automatic control systems containing more than one dynamic effect. The circuitry of pneumatic, hydraulic, and electronic controls is described in Chapters 7, 8 and 9, and a group of representative applications is described in chapter 10. The final two chapters are concerned with theoretical evaluation of control processes and means of determining stability by study of roots of equations describing dynamic characteristics of the systems.

Product Design in Western Germany

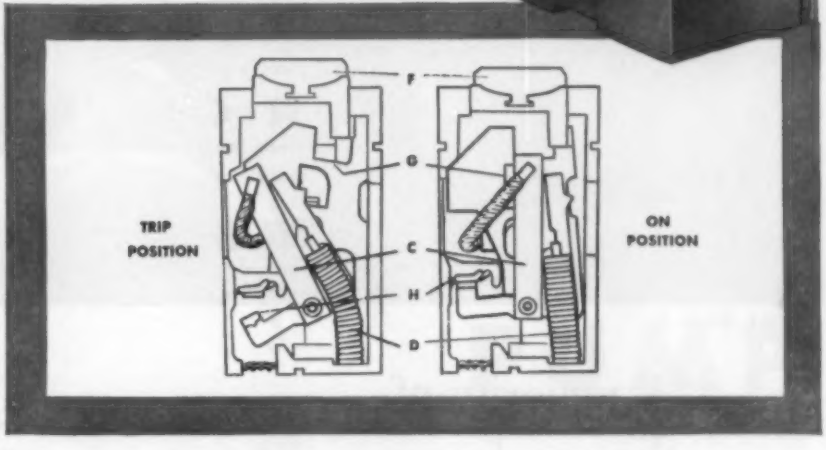
First articles in a series coming from Editor Nordenholt's extended visits with leading engineers in western Germany will appear in:

December. First part of a two-part article on "Electrohydraulics in Machine Tools," by A. Durr of Gebr. Heller in Nurtingen, developing the thesis that electrical components form the nerves and hydraulic systems the muscles in machine control.

January. "Germany Resurgent," an analysis by Editor Nordenholt of the factors responsible for the phenomenal rebirth of western Germany's industry; the importance attached by the Germans to education for engineering; recognition given engineering, and the dominance of engineering in management; the will of the people to work and follow strong leadership.

How Chace Thermostatic Bimetal Actuates the BULLDOG DUO-GUARD PUSHMATIC® CIRCUIT BREAKER

Product of Bulldog Electric Products Company, Detroit 32, Michigan



Bulldog's Duo-Guard Pushmatic Circuit Breaker features two separate protective devices for instant response to electrical overload. A Chace Thermostatic Bimetal element regulates normal overloads in the lower current range. A magnetic solenoid provides protection against sudden high overloads and shorts.

How it works—pushing down on the operating button (F), causes the latch end of the bimetal element (C) to engage a slot in the insulated contactor support (G), closing the circuit. A gradual overload causes the bimetal to deflect laterally, disengaging at (G). The main spring (D) provides sufficient force to effect a quick break at contacts (H). The breaker is reset by pushing down on the operating button (F).

High over-currents create a magnetic field in the solenoid, thrusting a plunger against the bimetal element to trip the contactor arm and instantly break the circuit.

Write now for our free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal," filled with design and application information about the 29 different types of Chace Thermostatic Bimetal.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1607 BEARD AVE., DETROIT 9, MICH.

JOSEPH P. SPANG JR.

Portrait by Fabian Bachrach

"A majority of the employees at Gillette..."

"The United States Savings Bonds program is good for the personal security of the bond buyer—good for the security and economy of the Country. A majority of the employees at Gillette Safety Razor Company purchase Savings Bonds the payroll savings way. Under this plan they find it easy to save a tidy sum for retirement years, to pay that unexpected bill, or meet the expense of other emergencies that arise."

JOSEPH P. SPANG JR., ***President***
The Gillette Company

If less than 50% of your employees are enrolled in the Payroll Savings Plan . . . if you have not conducted a person-to-person canvass in the past two years *(or if you do not have the Plan)*, act now! Telephone, wire or write to Savings Bonds Division, U. S. Treasury Department, Washington, D. C. You will hear promptly from your State Director, who will be glad to help you conduct a person-to-person canvass that will put an application blank in the hands of every employee. That is all you have to do. Your employees will do the rest. They want to save for their personal security.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

Product Engineering

OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

Help Wanted on Handbook

To the Editor:

Several months ago, the Army Ordnance Corps initiated the preparation of a comprehensive "Ordnance Engineering Design Handbook" to summarize fundamental principles and basic design data. The handbook is being written to provide needed information to Army ordnance and arsenal personnel and to the engineering staffs of contractors having ordnance design responsibilities. It is planned that the handbook will consist of approximately 180 sections of about 100 pp each. Completion of the first edition is expected to require about five years. The format is being worked out so as to facilitate revision of individual sections as may be required by future developments in the ordnance field.

This letter is being written to enlist the aid of your readers. Specifically, I would like to hear from those among them now actively interested in terminology and nomenclature problems. Whether the activity is on a vocational or avocational basis is unimportant—we would like the help of all who feel they have something to contribute.

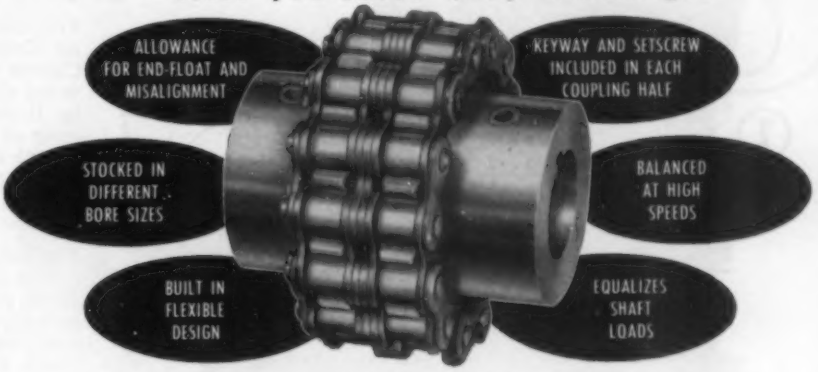
As you know, ordnance engineering cuts across many fields of science and technology, and information for design work is drawn from many diverse fields of knowledge. It is a matter of considerable importance that uncertainties as to the meaning of terms in use do not impede ordnance design and development. It is no easy matter to establish definitions for many ordnance terms that are also used in other areas of science and technology. Cooperation in avoiding confusion should prove helpful not only to designers and users of ordnance, but also to your readers—even those who may never have any direct contact with ordnance problems.

Overall editorial responsibility for the Ordnance Engineering Handbook-

(Continued on page 449)

only **cullman** FLEXIBLE COUPLINGS

offer you these many advantages


ALLOWANCE FOR END-FLOAT AND MISALIGNMENT
KEYWAY AND SETSCREW INCLUDED IN EACH COUPLING HALF
STOCKED IN DIFFERENT BORE SIZES
BALANCED AT HIGH SPEEDS
BUILT IN FLEXIBLE DESIGN
EQUALIZES SHAFT LOADS

Just three parts are needed — two hardened steel sprockets and a length of Cullman double strand roller chain.

For top performance, economy and long service life specify Cullman Roller Chain Flexible Couplings.

"Off-the-shelf" service on fractional to 500 horsepower ratings.

For full information see your Cullman distributor, or write for Catalog #51 TODAY.

cullman
POWER TRANSMISSION ROLLER CHAINS AND SPROCKETS
33551

REPRESENTATIVES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES
CULLMAN WHEEL COMPANY, 1334 ALTGELD ST., CHICAGO 14, ILLINOIS

LEGAL NOTICE

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)
SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION

Of Product Engineering published monthly with add'l issue in mid-October, at Albany, N. Y., for October 1, 1955.

1. The name and address of the publisher, editor, managing editor, and business manager is: Publisher McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, N. Y.; Editor, George F. Nordenholt, 330 West 42nd Street, New York 36, N. Y.; Managing editor, Robert W. Carson, 330 West 42nd Street, New York 36, N. Y.; Business manager, B. T. Douglas, 330 West 42nd Street, New York 36, N. Y.

2. The owner is: McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, N. Y.; Stockholders holding 1% or more of stock: Donald C. McGraw and Willard F. Chevalier, Trustees for Harold W. McGraw, Donald C. McGraw and Elizabeth M. Stoltzfus, all of 330 West 42nd Street, New York 36, N. Y.; Donald C. McGraw and Harold W. McGraw, Trustees for Catherine M. Rock, 330 West 42nd Street, New York 36, N. Y.; Donald C. McGraw, 330 West 42nd Street, New York 36, N. Y.; Mildred W. McGraw, Madison, New Jersey; Grace W. Mehren, 536 Arenas Street, LaJolla, California; Touchstone & Company, c/o Wellington Fund, Inc., Claymont, Del.

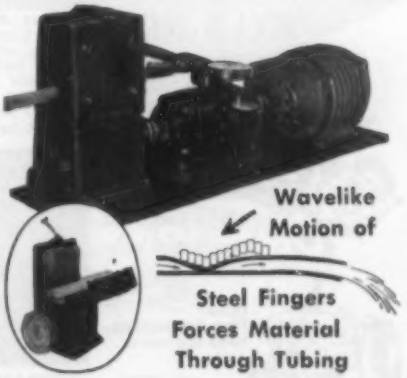
3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

McGRAW-HILL PUBLISHING COMPANY, INC.
By J. A. GERARDI, Vice Pres. & Treas.

Sworn to and subscribed before me this 15th day of September, 1955.
[SEAL] ELVA G. MASLIN.
(My Commission expires March 30, 1956)

PUMP
Liquids • Gases • Slurries
WITHOUT CORROSION OR CONTAMINATION

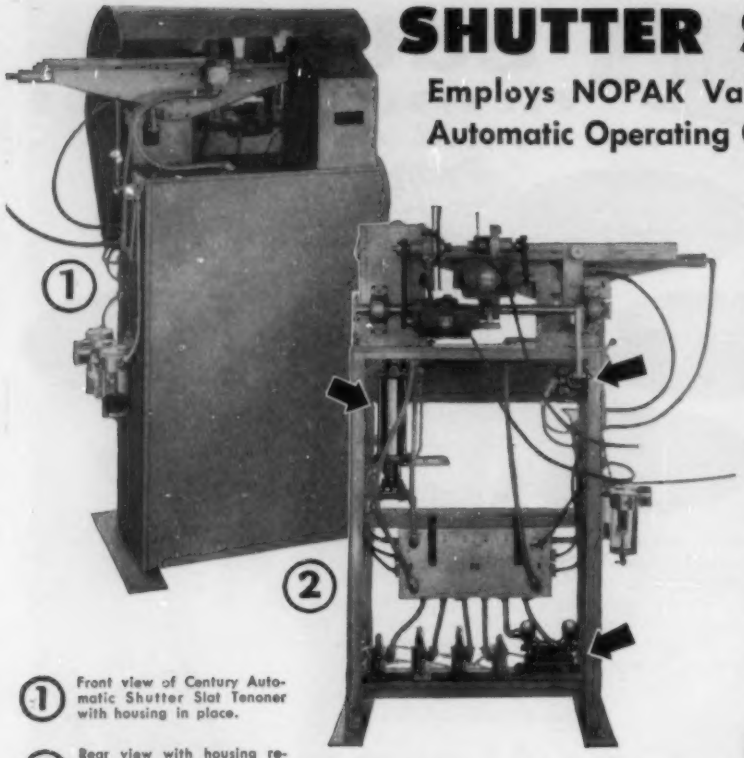


Prices range from ..... $55 to $500
depending on size of pump and accessory equipment required.

Write for Catalog
SIGMAMOTOR Inc.
31 North Main Street Middleport, N. Y.

SHUTTER SLAT TENONER

Employs NOPAK Valves and Cylinders to Implement Automatic Operating Cycle



This completely automatic machine, built by Century Tool and Engineering Co., Culver City, Cal., turns out 1200 tenoned wood shutter slats per hour, *automatically*. It cuts dowel-like projections on both ends of each slat and cuts the individual pieces to length. The machine continues to re-cycle automatically until the complete length of stock is cut into tenoned shutter slats.

The cutter head is moved into position by a 2" x 2" Model E NOPAK Cylinder. The stock is rotated 360°, during the cutting operation, by a NOPAK 2½" x 6" cylinder, controlled by a NOPAK Model V250-R Slide Valve.

This is but one example of how NOPAK Valves and Cylinders are used in automated operating cycles in many types of machinery and equipment. For other examples, ask your NOPAK Representative to show you the NOPAK Application Manual.

① Front view of Century Automatic Shutter Slat Tenoner with housing in place.

② Rear view with housing removed, shows 2 NOPAK Model E Cylinders and NOPAK Model V250-R Slide Valve.

GALLAND-HENNING NOPAK DIVISION
2762 SOUTH 31ST STREET • MILWAUKEE 46, WISCONSIN

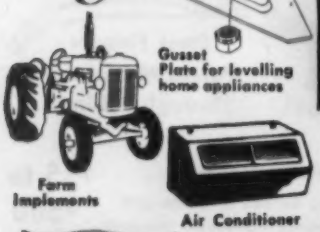
NOPAK
® VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

WHEN YOU NEED *Quicker Fastening*
FOR
- Blind Assemblies or
- Extra Threaded Depth at less cost...

use one of these 2 **WELD NUTS**

Gripco Pilot-Projection Weld Nut. Circular pilot designed for quick, easy positioning of nut over bolt hole for instant resistant welding. No jigs, no fumbling, no waste of time. Furnished with or without famous Gripco locking feature.

Gripco Countersunk Weld Nut. Eliminate time-wasting retapping of nuts after welding. Exclusive countersunk nut bottom does away with fouling of nut threads by weld spatter. Available with or without Gripco locking feature.



Write for sample and full details. NO. 114

GRIP NUT COMPANY
308-J S. Michigan Ave. • Chicago 4, Ill.

A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

McGraw-Hill Publishing Company, Room 2710, 330 West 42nd St., New York 36, N.Y.

has been assigned to the Ordnance Engineering Handbook Office established by the Office of Ordnance Research at Duke University, Durham, N. C. The Center for Documentation and Communication Research at Western Reserve University, Cleveland, Ohio, is cooperating with the Engineering Handbook Office in the important area of terminology definition. We are initiating our part of the project by a survey of sources, of information relating to terminology of importance to ordnance. It is with our office here at Western Reserve University in Cleveland that your readers are asked to communicate.

ALLEN KENT
Cleveland, Ohio

Ed–Should any readers feel that they have something to contribute to this ordnance engineering handbook project, it is suggested that they write directly to Mr. Kent.

Drafting Procedures

To the Editor:

The August article "Drafting Procedures" by H. H. Ash is the first intelligent approach to true simplification of drafting procedures. Kindly pass on my congratulations to him for some clear thinking.

My first thought on the various so-called simplified drafting procedures was quite favorable. However, close inspection of the suggested systems I have seen raised the question, "Simplification for whom?"

The obvious answer is—simplified for the draftsman. For the user it complicates the system many times over. The only possible exception being when the user has been trained along the same lines.

Incidentally I find that many companies do a poor job of making drawings and their engineering records are almost non-existent, a penny wise and pound foolish situation (or perhaps these particular manufacturers are not aware of the necessity).

L. E. O'NEIL
Dayton, Ohio

Ed–Simplified drafting, both the pro and con of it, continues to excite the interest of readers. But the total number of readers heard from is still too small . . . have we heard your opinion yet?

Technical assistants

for **ELECTRON TUBES**

The Electron Tube Laboratory is engaged in research and development in the fields of direct-viewing storage tubes and microwave tubes. The personnel comprises men with many years' experience in the field of electron tubes and their applications.

Very new developments in microwave and display tubes have created a number of openings at the research and development level for Laboratory Assistants. At Hughes, engineers, scientists and technicians develop their ideas from inception to quantity production. Thus, assistants working with electron tube products have unlimited scope for applying their talents and skills to a wide range of military and commercial uses.

You should qualify in any **3** *of the following areas:*

Electron Circuitry and Test Equipment Construction
Mechanics and Benchwork Skills
Tube Fabrication Techniques
High Vacuum Techniques
Microwave Testing
Tube Chemistry
Precision Assembly

SCIENTIFIC STAFF RELATIONS

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

HOW ARE YOUR COMMUNICATIONS ?

Do the booklets, pamphlets, and manuals you use really *work* for you? Are these vital publications, that tell the story of your products and your company, as effective, readable, well designed and illustrated as they can be? Today more than ever, your entire operation is judged by each annual report, employee manual, and public relations piece that you produce. Have you examined your communications lately? If you have any doubt as to the impact of your instructional and promotional literature, remember . . .

COMMUNICATION IS OUR BUSINESS

For a good many decades McGraw-Hill has stood for complete coverage in the business literature field. Now the McGraw-Hill TECHNICAL WRITING SERVICE offers a new approach to your publication problems – an *integrated* writing, editing, illustrating, and printing service for the *custom* production of: INSTRUCTION MANUALS, PRODUCT BULLETINS, TRAINING AIDS, INDUSTRIAL RELATIONS LITERATURE, ANNUAL REPORTS, COMPANY HISTORIES, PROCEDURAL GUIDES and other collateral literature. More than 150 editorial and graphic experts are at your disposal, ready to prepare high-quality material to your own or government specifications. Save time, save money . . . and make your communications work! Let *our* staff be your staff for technical and business publications.

McGraw-Hill Book Co. TECHNICAL WRITING SERVICE

Write or phone Technical Writing Service, McGraw-Hill Book Co., Inc.
330 West 42nd Street, New York 36, N. Y. • LOngacre 4-3000

This service is available through ad agencies.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

UNDISPLAYED RATE

$1.50 ($1.80 effective Jan. 1956) a line, minimum 3 lines.

To figure advance payment count 5 average words as a line.

Box Numbers—Care of publication count as one line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Equipment Wanted or For Sale Advertisements acceptable only in Displayed Style.

DISPLAYED RATE

Individual Spaces with border rules for prominent display of advertisements.

The advertising rate is $15.10 ($16.85 effective Jan. 1956) per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.

INVENTIONS WANTED

Patented or unpatented products in any field. No fees. Write for Brochure L-1.

INDUSTRIAL CHAMBER OF COMMERCE
58 Broad St. • Bloomfield, N. J.

10 to 12 ft. lengths
ALL METALS
Also Screw Machine Products to Order

EASTERN
Machine Screw Corp.
12-32 Barclay St.
New Haven, Conn.
Makers of H & G Die Heads

PROFESSIONAL SERVICES

DESIGN ASSOCIATES
Tool Designing Available
Jigs, Fixtures, Progressive and Compound Dies
Layout and Detailing Service
2439 N. Charles St. Baltimore 18, Md.

GEORGE H. KENDALL
Consulting Mechanical Engineers
Methods Studies; Process or Product Redesign Existing Products for Greater Profit, Trouble Shooting Production, Design, Cost Problems, Specialist Automatic Machinery, Process, Controls, New Developments, Patent Studies, Investigations, New Products & Process Engineering Studies
P. O. Box 3 (*Est.* 1923) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

WILLARD F. MASON
Consulting Electrical Engineer
Precision Electromechanical Designs
Specialist Slip Ring Assemblies—All Applications
Engineering Administration, Cost Systems
Product Development Programs
Manufacturing Facilities
180 Post Road, Darien, Conn. Oliver 5-9939

NEW PROVIDENCE ELECTRIC CO.
ELECTRO-MECHANICAL DESIGN DEVELOPMENT SERVICE
New Product Development • Redesign • Automation
Special Machines and Systems
Service Facilities incl. drafting, machining, fabrication and electrical laboratory.
General Office—505 New Center Bldg., Detroit 2, Mich. TR 1-2641
Eng. & Plant, 30125 Groesbeck Hwy. Roseville, Mich.

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

RATES

DISPLAYED

The advertising rate is $19.85 ($23.20 effective Jan. 1956) per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED

$1.50 ($1.80 effective Jan. 1956) per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to PRODUCT ENGINEERING, 330 W. 42nd St., N. Y. 36, N. Y., for August issue closing July 21st.

WANTED: PRODUCTION ENGINEERS

The increasing complexity of products in Honeywell's expanding Aeronautical Controls Division has created several openings for experienced Production Engineers.

REQUIREMENTS

A broad engineering knowledge equivalent to B.M.E. or B.E.E. Degree, plus 5 years Production Engineering experience. Experience should have included major responsibility for process planning on new products, such as precision mechanical, electrical, or hydraulic equipment, electro-mechanical controls, servo-mechanisms, electric motors, instruments, or gyros. Thorough knowledge of tooling, estimating, metals fabrication, manufacturing, and assembly operations.

CONSIDER THESE ADVANTAGES:

Ideal suburban living in friendly, uncrowded Minneapolis, famous for its cultural activities, recreational facilities.

Generous employee benefits include broad company-paid insurance and pension plans, liberal tuition allowances for advanced study.

Travel and family moving expenses paid.

Please send résumé of your background including salary requirements, to:

J. A. HILL
Engineering Placement Manager
Minneapolis-Honeywell Regulator Company
2753 4th Avenue South
Minneapolis 8, Minnesota

MINNEAPOLIS **Honeywell** *First in Controls*

• CHIEF ENGINEER

Complete responsibility over all engineering activities including research and development. Seasoned engineering executive with sound educational background thoroughly familiar with electro-mechanical rotating equipment and systems in aircraft accessories field.

Prefer man 35 to 50, holding comparable position whose success is a matter of record "in the trade." Send full resume in strict confidence, including salary desired, to:

AIRBORNE
ACCESSORIES CORPORATION

Mr. L. Genesson
1414 Chestnut Ave.,
Hillside, N. J.
WAverly 6-1700

Farnsworth IT&T **has a future for ELECTRONIC ENGINEERS**

in these specialized fields

MISSILES

Research, systems analysis, development, and design in guidance and control systems, systems component equipment, and systems operational test equipment.

TEST EQUIPMENT

Research, development, and design in Guided Missile operational test equipment systems and systems component equipment.

MICROWAVES

Systems analysis, development, and design in microwave circuitry and components for missile guidance systems, radar systems, and systems test equipment.

RADAR

Study, analysis, development, and design in highly advanced radar techniques, and electronic countermeasures.

ANTENNAS

Research, development, and design of airborne antennas in low-frequency, UHF, and microwave regions for missiles, radar, and countermeasures equipment.

PACKAGING

Encapsulation and subminiaturization design for reliability and producibility in missile guidance and control equipment systems, airborne radar systems, operational systems test equipment, closed-loop TV systems, etc.

Career-minded men with several years specialized experience, and preferably with advanced degrees, are invited to join our rapidly expanding programs in industrial and military electronics.

Address inquiries to:

Technical Employment Manager

FARNSWORTH ELECTRONICS CO.,
Fort Wayne, Indiana
A division of International Telephone and Telegraph Corp.

ENGINEERS Electronic • Mechanical DESIGNERS • DRAFTSMEN

How do you Measure success?

Some measure success only by money; others by the enjoyment they get out of their work. But the true measure of success is a combination of both *plus* the knowledge that your efforts are recognized and appreciated.

Melpar engineers find diversity and opportunity for professional growth; they enjoy being part of a highly creative staff without losing their individuality; and they benefit from Melpar's completely integrated facilities for system responsibility from design concept through production.

To learn how Melpar measures up to your own standards send complete resume to

Technical Personnel Representative

- Network Theory
- Systems Evaluation
- Automation
- Microwave Technique
- UHF, VHF or SHF Receivers
- Analog Computers
- Digital Computers
- Magnetic Tape Handling Equipment
- Radar and Countermeasures
- Packaging Electronic Equipment
- Pulse Circuitry
- Microwave Filters
- Flight Simulators
- Servomechanisms
- Subminiaturization
- Electro-Mechanical Design
- Quality Control & Test Engineers

melpar, inc.

Subsidiary of Westinghouse Air Brake Co.

3000 Arlington Blvd., Dept. PE-23 Falls Church, Va.

11 Galen Street, Watertown, Mass. • 99 First St., Cambridge, Mass.

Product Engineers

Challenging positions for five ENGINEERS or PHYSICISTS who are interested in being associated with a leading instrument company.

MECHANICAL ENGINEERS experienced in design and development of electromechanical instruments including production engineering followup. ELECTRICAL ENGINEERS OR PHYSICISTS experienced in:

1.

Analyzing operations of vacuum tube amplifiers and servosystems and devising corrective solutions where performance is substandard.

2.

Specifying electrical components and supervising their placement within an electrical system.

We design and manufacture a variety of instruments and systems for analysis and control: infra-red spectrophotometers, and continuous analyzers, nuclear magnetic resonance equipment, and gas chromatography instruments . . . Also we design and manufacture precision optics and optical systems.

For consideration please contact or submit detailed resume to Personnel Manager.

THE PERKIN-ELMER CORPORATION

Main Avenue Norwalk, Conn.

Lockheed diversification in action...

Below: engineers and scientists work on some of the 46 major projects in progress at Lockheed

Operations Research discussion on continental defense

Operations Research openings

Electronics Specialists
Fire Control and Guidance Specialists
Aerodynamics Engineers
Physicists

Fatigue test on Super Constellation skin

Structural Engineering openings

Research Specialists
Structures Engineers
Stress Analysts
Weight Engineers

Hot-air cyclic de-icing test on radar search plane

Thermodynamics openings

Research Specialists
Thermodynamics Engineers
Thermodynamicists

Design study on hydraulic requirements of new transport

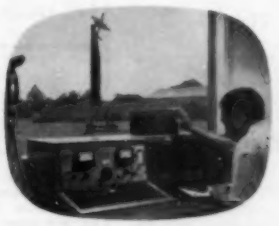
Design openings

Design positions are open at all levels in controls, electrical, hydraulics, mechanical, power plant and structures fields.

IBM 701 applied to jet transport flutter problem

Math. Analysis openings

Math. Engineers
Math. Specialists
Math. Analysts



Antenna pattern study on radar search planes

Electronics openings

Electronics Research Engineers
Airborne Antenna Designers
Research Specialists

In-flight test on air speed performance

Flight Test Engineering openings

Flight Test Engineers
Flight Test Analysts
Instrumentation Engineers
Electrical Research Engineers

Aerodynamic meeting on high-speed fighter

Aerodynamics openings

Aerodynamics Engineers
Aerodynamicists
Dynamics Engineers
Wind Tunnel Test Engineers

Why Lockheed offers Engineers better careers

There are three main reasons:

1. More opportunity for promotion
because there are more supervisory positions to be filled with 46 major projects underway, including 13 models of aircraft on assembly lines.

2. More career security
because Lockheed activities cover virtually the entire spectrum of aeronautical endeavor.

3. Life in Southern California
Scenic beauty, unmatched climate, wide recreational opportunities enhance life in the San Fernando Valley.

To Engineers who lack aircraft experience

Aircraft experience is not necessary to join Lockheed. It's your engineering training and experience that count. Lockheed trains you for aircraft engineering – at full pay.

Coupon below is for your convenience in requesting application form and more information on how Lockheed's expanding program can advance your career.

E. W. Des Lauriers, Dept. C-30-11

Lockheed AIRCRAFT CORPORATION
CALIFORNIA DIVISION • BURBANK
California

Please send me a brochure describing life and work at Lockheed and an application form.

Name

Field of Engineering

Street Address

Home Phone

City and State

TWO KEY POSITIONS OPEN FOR
MECHANICAL ENGINEERS
IN MILITARY WEAPONS SYSTEMS WITH RCA

1 MISSILE GUIDANCE SYSTEMS INTEGRATION
You must be able to originate new systems concepts as applied to weapon control systems. Experience must include integration or coordination of weapons systems or large radar systems. BSME necessary, plus 10 years' experience in mechanical design of military electronic equipment.

2 MECHANICAL DESIGN CONSULTANT
You will direct the mechanical design of weapons systems and radar, to attain low cost, design simplicity and high productivity. BSME necessary, plus 15 years' electronic experience in fabrication, assembly finishing, cost analysis and design of military electronic equipment. Supervisory and processing experience in light metal fabrication desirable.

In these high level positions, there's excellent opportunity to advance with RCA's engineering staff in the complex, challenging guided missile field. You will work in RCA's new, completely equipped engineering laboratories in Moorestown, N.J. You and your family will enjoy living in nearby suburban communities, with fine schools.

Please send resume of education and experience to:

Mr. John R. Weld, Employment Manager
Dept. B-13L, Radio Corporation of America
Camden 2, N.J.

RADIO CORPORATION OF AMERICA
ENGINEERING PRODUCTS DIVISION

EXPERIENCED DESIGNERS-LAYOUT MEN

TO WORK AT GENERAL MOTORS NEW TECHNICAL CENTER

For Experimental Automotive Work in Transmissions, Engines & Chassis.
The work of this group is carried on in one of the nations most modern and complete research and development centers; located in suburbs of Detroit, Michigan. Exceptional opportunity for men looking to the future. Positions are permanent due to long-range plans. Outstanding company benefits.

State Full Particulars; Age, Experience, Salary Expected Etc. Send Resume to:

PERSONNEL DEPT.
ENGINEERING STAFF
GENERAL MOTORS CORPORATION
G. M. Technical Center **Detroit 2, Mich.**

DEVELOPMENT ENGINEER
A nationally known manufacturer of household appliances located in N.Y.C. needs a Development Engineer who is experienced in designing and developing consumer products; who is creative and gadget minded and who can exercise his ingenuity and inventiveness in the light of the practical and cost-conscious mass production techniques. Submit your resume and be assured that it will be treated in strictest confidence. Personnel of our engineering dept were advised about this ad.
Box PE 222, 221 W 41 St, NY 36

ASSISTANT TO
TECHNICAL DIRECTOR
The Research Division of one of nation's most progressive manufacturers of highly engineered products for aviation, automotive, electronic and machine tool industries.
Administrative experience in project engineering and technical writing helpful.
Company pays all fees and expenses.
MONARCH PERSONNEL 28 E. Jackson Chicago 4, Ill.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1111 Wilshire Blvd. (17)

POSITIONS VACANT

Mechnical Designer—exceptional opportunity for man with partial college education or equivalent and 5-10 years industrial experience in the design of heavy machinery, conveyors, drives, plant lay-out, and production lines; must be able to make and check calculations, specify standard commercial items, or design special equipment where necessary. Favorable North Jersey location with excellent employee benefits. Write with full particulars including salary required. P-8134, Product Engineering.

DIRECTOR OF ENGINEERING

An old established company can offer an outstanding and challenging opportunity for a capable engineering executive to direct research and engineering activities. The company is engaged in the manufacture and marketing of a diversified line of established equipment in recreation, education, and defense fields. Products cover a broad range of materials, including steel, aluminum, rubber, plastics, and wood.

The scope of engineering responsibilities will encompass industrial design, mechanical equipment design, materials research, and plastics and rubber product development. A very capable mechanical engineering and chemical engineering staff is available to support the top man. The budget for these activities is approximately $400,000 annually.

The man we seek must have several years of successful experience in the direction of broad engineering programs and must have held a position as chief engineer or research director for a medium size company, or divisional engineering supervisor for a large corporation. He must have a mechanical engineering degree.

A very attractive salary and fringe benefit arrangements are available to the successful candidate. Location is in Midwest.

P-7881, Product Engineering
520 No. Michigan Ave., Chicago 11, Ill.

POSITIONS VACANT

Consultant in design and tooling for commercial and domestic electric cooking and heating appliances. Services available on per diem or fee basis. P-8029, Product Engineering.

Development and Design Engineer—Transportation Equipment. Leading manufacturer of air conditioning, heating, ventilating and heat transfer equipment needs an engineer with approximately 5 years' experience in the development of transportation equipment. Two of these years in refrigeration equipment preferred. Opportunity to design and develop new apparatus for a pioneer company in the air conditioning of trains and buses and refrigeration of reefer cars. Applicant must be a mechanical engineer with a B.S. or M.S. degree. Send resume of experience to: Manager of Staff Employment, The Trane Company, La Crosse, Wisconsin.

Machinery Designer—Excellent opportunity for man with partial college education or equivalent and 5-10 years experience in design of automatic machinery for material handling and processing; and ability to design and create labor saving equipment. Must have experience in heavy machinery, conveyors, drives; and leadership potential to head jobs and distribute work. Liberal employee benefits. Location North New Jersey. Write with full particulars including salary requested. P-8148, Product Engineering.

When Writing Your Ad

Provide an indexing or subject word.

Write it as the first word of your ad.

If it is a Position Wanted or Position Vacant ad, make the first word the kind of position sought or offered.

The right is reserved to reject or revise all Want Advertisements.

Classified Advertising Section

PRODUCT ENGINEERING

Index of

PRODUCTS ADVERTISED

In This Issue

A

Accelerometers 376
Accumulators 85
Actuators
Hydraulic 280
Mechanical 326, 407
Adhesives 64, 442
Alternators (See Generators)
Aluminum Alloys 35-38, 51, 52-53, 90-91, 112-113, 256, 388, 423
Aluminum Coated Sheet and Strip (see Steel, Coated)
Amplifiers 254, 293
Assemblies
Hydraulic 85, 265
Pneumatic 262-263
Structural 391

B

Balls 330, 426
Bars
Metal 51, 75, 84, 283, 404
Bearing Covers 418
Bearings
Ball 42, 103, 128, 229, 286, 330, 364, 426, 432
Jewel 382
Miniature 128, 364, 468
Needle 88
Oil-less 57, 109
Roller ..... 4th Cover, 42, 99, 103, 221, 229, 364, 395
Sleeve 57, 109, 283, 357, 404
Bellows 236-237, 279, 372, 400
Belts 242-243, 384, 455
Bi-Metal 31, 445
Blowers 356
Bolts 22-23, 58-59, 84, 315, 325
Boosters 85
Brake Motors 60-62
Brakes
Hydraulic 374
Mechanical 374
Brass 2, 84, 95
Bronze 76, 84, 256
Brush Holders 388
Bushings 328, 404

C

Cabinets 434
Cam Followers 221
Carbon 44-45
Casters 383
Castings 20-21, 112-113, 255, 283, 389, 466
Castings, Precision Investment ... 32, 332, 336, 368, 396
Ceramics 386

Continued on p. 456

Mor-Grip v-belts

FHP

MULTIPLE

SUPER RATED

STEEL CABLE

OPEN END

HEX BELTS

V-LINK

Maurey *engineers* v-drives for every situation; the "stop and go" spurts of refrigeration drives; the pulsating, high torque loads of rock crushing; the smooth, steady-pull of textile drives... for short centers, and wide range of speed ratios. Maurey V-drive equipment has proved its value since 1917, improving the performance, and increasing the sales of thousands of products. Maurey delivers pulleys, belts and accessories *quickly* from complete stocks. Whether you are designing a new v-drive or improving an old one, contact Maurey. Call your local Maurey Distributor, or write direct.

Request these catalogs

Write to

Pulleys, Sheaves V-Drive Accessories

1-GROOVE CAST IRON

PRESSED STEEL

4-GROOVE CAST IRON

VARIABLE PITCH

STEEL SHAFT COLLARS

REFRIGERATION FANS

Q-D SHEAVES

maurey manufacturing corp.

2903-27 SO. WABASH AVE., CHICAGO 16, ILL.

DESIGNERS

send us your telephone number

...it may mean a better future for you!

Because of increased emphasis on some of our long-range projects, we want to establish immediate contact with competent designers.

To those who qualify, we can offer a real opportunity to build solid, well-rewarded careers.

If you want a chance to grow, attractive wage rates, extra benefits, New England living — mail this coupon today!

Particularly important is your telephone number. We may want to call you at once to arrange for personal interviews or plant visits.

Mr. P. R. Smith
Dept. 7, Design Employment
Pratt & Whitney Aircraft
East Hartford 8, Conn.

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

☐ Nuclear Design ☐ Aerodynamics ☐ Bearings
☐ Compressors ☐ Hydraulics ☐ Piping
☐ Turbines ☐ Gears ☐ Controls
☐ Structures ☐ Valves ☐ Test Equipment
☐ Afterburners and Related Equipment ☐ Heat Exchangers and Combustion Problems ☐ Test Rigs

Total years Mechanical Design experience .....

You can reach me at ..... Most convenient (telephone number) hours for receiving calls are between ..... and .....

NAME .....

ADDRESS .....

CITY ..... STATE .....

Mail this coupon TODAY!

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut

World's foremost designer and builder of aircraft engines

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 455

Chains
Bead 250
Conveyor 13, 370
Roller 13, 249, 258, 370, 447
Silent 13, 249

Chemical Treatments 8, 292, 296, 300

Circuit Breakers 116-120

Clad Metals 234

Clamps 418, 444

Clamps, Hose 348

Clips 126

Clips, Electrical 423

Closures 402

Clutches
Mechanical 68, 249, 266, 385, 386

Coatings ..... E, 64, 241, 282, 292, 296, 414

Cold Headed Parts 325

Compressors 367

Computers 312

Connectors
Hose 265, 365
Tube 265, 365

Contactors 321

Controllers 442

Control Panels & Switchboards 18-19, 321

Controls
Electrical 116-120, 259, 321
Electronic ..... 18-19, 64 A & B, 235, 426
Hydraulic 85, 259, 299, 363
Mechanical 402
Pneumatic 114-115, 259, 299, 363

Conveyor Belts 416

Copper & Copper Alloys 102

Cork Compositions 39, 111, 462

Counters 17, 413

Couplings
Hose 265
Hydraulic 444
Mechanical 249, 266
Tube 265

Cupro-Nickel Alloys 98

Cylinders
Hydraulic 85, 271, 299, 343 344, 363, 448
Pneumatic 271, 299, 363, 448

D

Die Castings 97, 110, 246, 332, 366

Die Sets 270

Differentials 312

Drafting
Supplies 267, 275, 418, 420, 432, 436

Drives
Adjustable Speed 18-19, 116-120, 380
Hydraulic 380, 399
Right-Angle 417
Timing 322-323
Variable Speed ..... 3rd Cover, 15, 16, 85 114-115, 249, 327, 331, 367

Dynamotors 40-41

Index of

PRODUCTS ADVERTISED

In This Issue

•

E

Electrical & Electronic Components, Custom Made (see also Production Services) 254

Electrochemical Finishes & Treatments 241, 300

Engineering Services (see also Production Services) 34, 52-53, 77, 282 309, 373, 387, 412, 413

Engines 214, 309, 317, 430, 436

Expanded Metals 354

Extrusions
Metallic 2, 51, 69, 441, 442
Non-Metallic 108, 417, 426

F

Fabricated Plastics (See Plastics, Fabricated)

Fabricated Steel (see Plate, Fabricated, Sheet Fabricated, Structural Forms & Shapes, see Weldments)

Fabrics 297

Facings, Clutch 384

Fastening Methods 66, 126, 245, 388

Fibre 347, 350, 375

Fibre Glass 457

Filters
Air 109, 262-263, 428
Hydraulic 85, 109, 252-253, 428

Finishing Equipment & Supplies..... 292

Flexible Couplings..122, 266, 338, 405, 447

Floats 346

Forgings 90-91, 233, 307, 359

Friction Materials.....39, 104-105, 109 111, 384, 462

Furniture, Engineering Dept.....313, 378 432, 436

G

Gages, Pressure or Vacuum..... 238

Gaskets 104-105, 316

Gear Motors (see also Motor Reducers) 54-55, 60-62, 92, 305, 356

Gears.....6, 11, 43, 251, 322-323, 373 394, 403, 415, 423, 437

Generators
A-C 40-41, 356
D-C 40-41, 356
High Frequency 40-41, 356

Glass Parts 402

Graphite 44-45

H

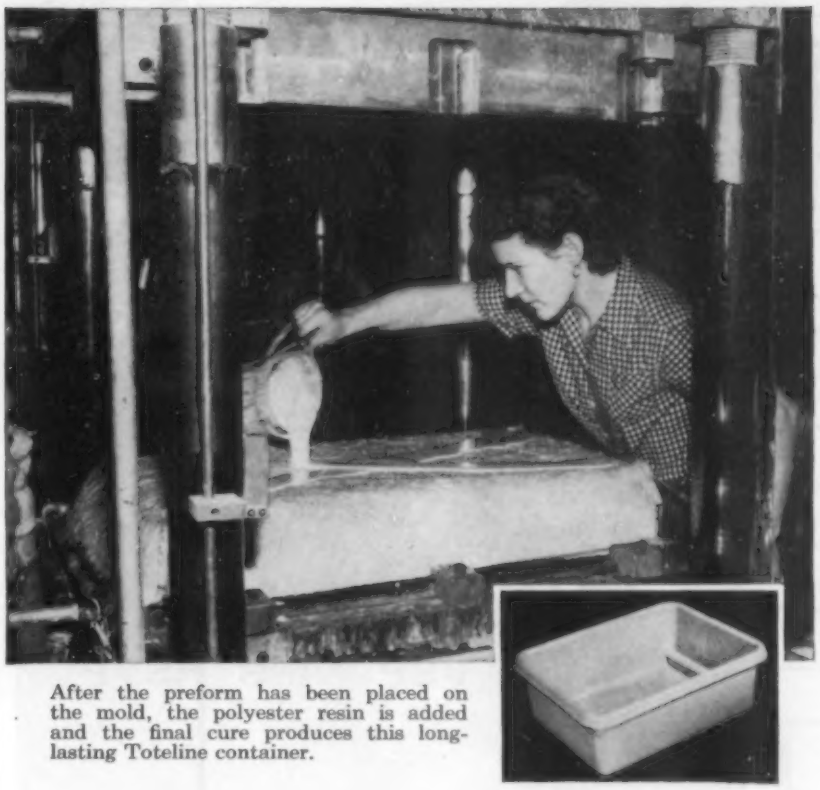
Hard Surfacing 433

Heating Units.....116-120, 250, 362, 420

Hermetic Seals 438

Hose & Tubing.....265, 308

Continued on p. 458



After the preform has been placed on the mold, the polyester resin is added and the final cure produces this long-lasting Toteline container.

"Garan Roving makes Toteline boxes chemically resistant, stronger, longer lasting"

—A. W. Levenhagen, president, Molded Fiberglass Tray Co.

"Toteline trays and boxes must withstand rugged treatment. That's why we use L·O·F Glass Fibers' Garan Roving. It has superior wetting-out characteristics, which give the boxes greater strength, and resistance to moisture and chemical agents. Garan Roving helps Toteline boxes last longer."

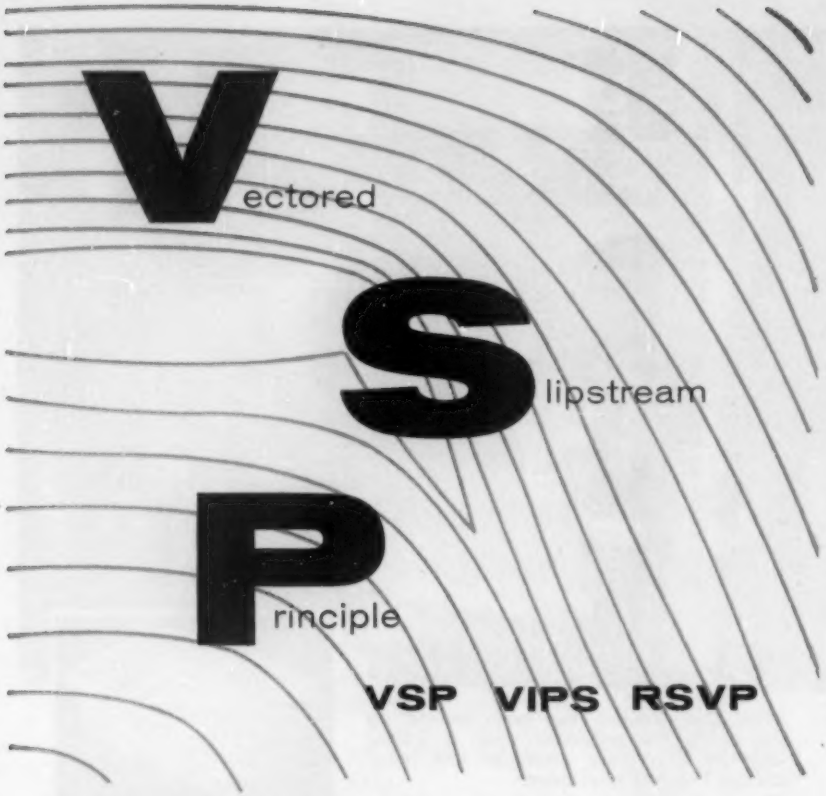
L·O·F Glass Fibers' exclusive Garanized ® roving imparts great flexural and tensile strength to reinforced plastics. It bonds strongly and uniformly to polyester molding resin, both chemically and mechanically. Such plastics, reinforced with Garan roving, are stronger and have higher wet-strength retention. For numerous applications with epoxy, silicone, polyester resins, Vitron® VR-12 Roving is finding wide use among molders.

For technical counsel on how Garan Roving can improve your product, contact our nearest sales office, or write: L·O·F Glass Fibers Company, Dept. 4-115, 1810 Madison Ave., Toledo 1, Ohio.

L·O·F GLASS FIBERS Garan ROVING

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO



Advanced research at Fairchild in the applications and effects of the Vectored Slipstream Principle has brought about the need for qualified aerodynamicists who have worked in this vital field, and who can make valuable contributions to its development.

Fairchild, producers of the famous C-119 *Flying Boxcar* and C-123 *Provider*, are now preparing transports, advance reconnaisance aircraft, fighters and missiles. Experienced aerodynamicists with VSP background will find these challenging new programs an exciting, stimulating climate in which to utilize and profit from their experience.

Investigate these forward-looking, pace-setting developments. If your experience and originality can advance Fairchild's rapidly-expanding program, you can be sure there's a big future waiting for you at Fairchild.

Investigate, too, the superb conditions for living and working near urban Baltimore and Washington, in the attractive Cumberland Valley. Fairchild offers outstanding company benefits: salary plans . . . paid pensions . . . health, hospitalization and life insurance . . . the many *extra* advantages of working with a genuinely progressive, fast-growing organization.

Send a detailed resume of your experience to Walter Tydon, Chief Engineer. All correspondence will be kept in strictest confidence, of course.

"where the future is measured in light-years"

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 457

I

Inspection Equipment 324

Instruments
- Electrical 387, 421, 439
- Hydraulic 439
- Mechanical 387, 424, 439

Insulation....290, 347, 349, 392, 442, 457

Insulators 444

J

Jewels 382

L

Laminated Metals 31

Laminated Plastics (see Plastics, Laminated)

Latches 56, 334

Liquid Level Controls..... 259

Lubricating Equipment..63, 262-263, 285

M

Machined Parts 109

Magnesium Alloys.....100, 406, 413, 442

Marking Machines & Tools..... 424

Metal Forming 52-53

Moldings
- Glass (see Glass Parts)
- Plastics (see Plastic Parts)
- Powdered Metal (see Powdered Metal Parts)
- Rubber (see Rubber Parts)

Motor Reducers (see also Gear Motors) 60-62, 305

Motor Starters..18-19, 64 A & B, 235, 426

Motors, A-C
- Fractional....28-29, 40-41, 60-62, 82-83 116,-120, 124, 248, 260-261, 272-273 305, 329, 331, 340, 355, 356, 397, 401
- Integral.....28-29, 40-41, 60-62, 82-83 116-120, 248, 272-273, 305, 331 345, 355, 397, 401
- Sub-Fractional.....28-29, 40-41, 82-83 116-120, 124, 248, 260-261, 335 356, 360, 401

Motors, D-C
- Fractional....28-29, 40-41, 60-62, 82-83 116-120, 124, 248, 260-261, 272-273, 329 331, 340, 356, 397, 401
- Integral.....28-29, 40-41, 60-62, 82-83 116-120, 248, 272-273, 331, 345, 397, 401
- Sub-Fractional.....28-29, 40-41, 82-83 116-120, 124, 248, 260-261, 335 356, 401

Motors, High Frequency
- Fractional 401
- Integral 401
- Sub-Fractional 401

Motors, Hydraulic...85, 342-343, 399, 401

Index of

PRODUCTS ADVERTISED

In This Issue

•

N

Nickel Alloys 98, 102
Nickel Silver 102
Nuts.....22-23, 56, 58-59, 66, 84, 87, 315 377, 423, 426, 448

O

Optical Parts 422

P

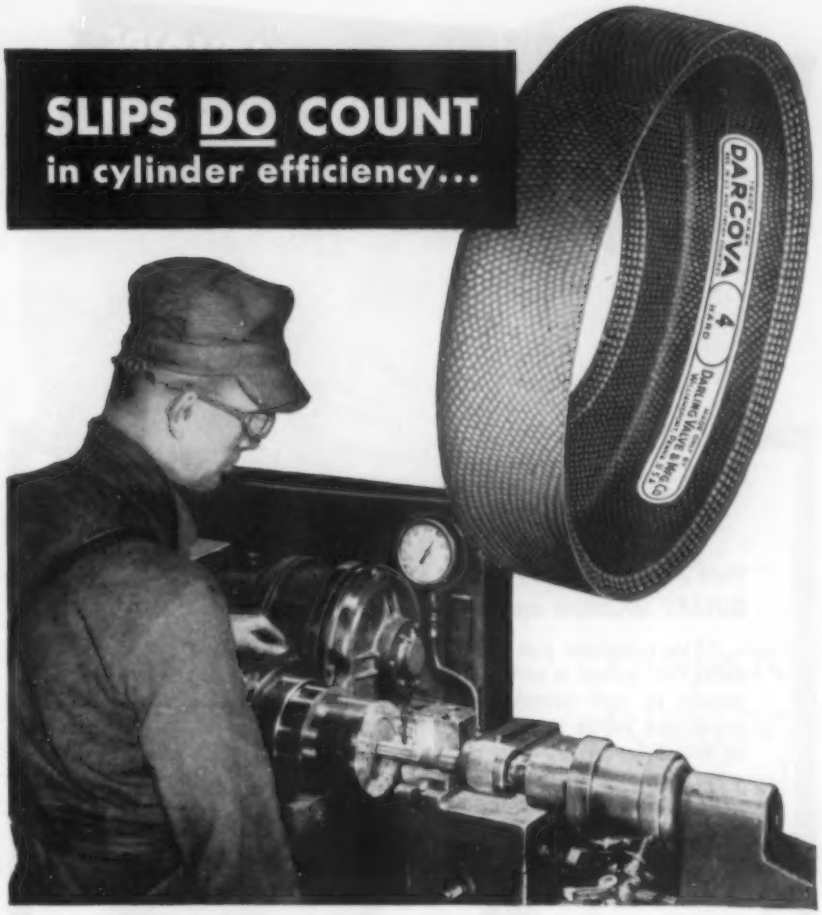
Packings..104-105, 301, 303, 351, 428, 459
Paper 244
Paper Insulation 347
Phospher Bronze 89
Photographic Equipment
  Film 267
  Paper 267
Pillow Blocks 13
Pins 84, 227
Pipe 121
Plastic Film 333
Plastic Parts 96, 104-105, 288 318, 390, 427
Plastics.....24-25, 32 A & B, 77, 94, 107 287, 290, 294, 318
Plastics Fabricated....108, 290, 318, 375
Plastics Laminated 290, 294, 339, 347 350, 375
Plates 312
Porcelain 402, 444
Powdered Metal Parts....57, 78, 104-105 109, 283, 371
Power Packs
  Hydraulic 85, 299
Power Take-offs 386
Production Machines & Processes... 352 403, 408, 432
Production Services (see also Engineering Services) 34, 50, 52-53, 96 309, 320, 373, 387, 391, 406, 413
Protective Devices, Motor..... 30
Pulleys 434, 455
Pumps
  Air 428
  Liquid....46, 85, 343, 367, 399, 401, 410 415, 428, 444, 447, 467
  Vacuum 428

R

Ratchets 403
Recorders 324
Rectifiers 409
Regulators
  Hydraulic 85
  Pneumatic 262-263
Relays.....26-27, 48-49, 64 A & B, 210 247, 277-278, 295, 321

Continued on p. 460

SLIPS DO COUNT in cylinder efficiency...



Now, cost-conscious engineers are standardizing on **DARCOVA PUMCUPS!**

Reason—On all types of air and hydraulic controls and mechanisms maximum volumetric efficiency is assured with Darcova Pumcups. Moreover, Pumcups outlast ordinary packing at least 3 to 1!

CHECK THESE OTHER ADVANTAGES TOO!

- Reduced operating speeds
- Fewer shutdowns
- Smoother operation
- Lower power costs
- Longer cylinder life
- Closer control

If your slippage is showing, write for Bulletin No. 4502 on Darcova Pumcups for air and hydraulic mechanisms . . . or Bulletin No. 4401 on Pumcups for reciprocating pumps.

DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

PUMCUPS

LEDEX ROTARY SOLENOIDS
GIVE POSITIVE, POWERFUL SNAP-ACTION!

Here's how a LEDEX ROTARY SOLENOID operates . . .

The magnetic pull moves the armature along the Solenoid axis. This action is efficiently converted into a rotary motion by means of ball bearings on inclined races. The inclined ball races are made to compensate for the magnetic pull increase as the Solenoid air gap closes, thereby providing substantially equal starting and ending torque during the rotary stroke. The rotary snap-action power of the Ledex can be efficiently harnessed with a minimum of linkages, through the use of one or more standard features available on all models.

Here's why LEDEX ROTARY SOLENOIDS are dependable!

As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled. The copper wire coil, the heart of the Solenoid, was developed especially for this product. It is wound by a precision winding process that puts a maximum amount of magnet wire into available space . . . giving tremendous power to compact Ledex Rotary Solenoids.

Basic sizes of LEDEX ROTARY SOLENOIDS to choose from!

Model No.	2	3	4	5	6	7	8
Diameter inches	1⅛	1⅝	1⅞	1⅞	2¼	2¾	3⅜
Torque lbs.-inches	.4	1.0	1.7	4.0	7.5	25.0	54.0

Torque values for normal intermittent duty and 45° stroke.

Engineering data is available upon request.
WRITE FOR DESCRIPTIVE LITERATURE TODAY!

J. H. Leland INC.
123 WEBSTER STREET, DAYTON 2, OHIO
IN CANADA: MARSLAND Engineering Ltd., KITCHENER, ONTARIO

Index of PRODUCTS ADVERTISED In This Issue

•

Continued from p. 459

Reproduction Equipment 313
Reproduction Supplies 267, 275
Resins 72-73, 107, 257
Retaining Rings 79, 436
Revolving Joints 314, 438
Rheostats 4, 277-278
Rings & Loops..... 233
Rivets 56, 66, 84, 315
Rod Ends 42
Rods
Metallic 84, 95
Rubber 47, 94, 281, 349
Rubber-Bonded-to-Metal 361, 405
Rubber Coated Parts..... 264
Rubber Parts ...14, 104-105, 284, 390, 417
Rust Proofing 8, 414

S

Scales 291
Screw Fasteners 56
Screws.....58-59, 70, 84, 276, 315, 325 414, 420, 423, 424
Seals....2nd Cover, 71, 269, 274, 285, 303 316, 361, 365, 428
Servomechanism Components 254, 293 312, 429
Shapes, Rolled Formed.....52-53, 69
Sheaves.....18-19, 242-243, 434, 455
Sheets
Metal 51, 234, 311
Plastic 288, 333
Rubber 297
Shock Absorbers 326
Silicone Rubber 297
Silicones .....96 A & B, 304
Solenoids.....319, 321, 381, 414, 460
Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.).. 56 66, 74, 315, 325, 334, 369, 393, 420
Speed Reducers 15, 43, 92, 327, 353
Splines 407
Springs.....379, 435, 440, 442, 464
Sprockets.....13, 249, 258, 403, 434, 447
Stampings 52-53, 348, 440
Steel
Alloy.....67, 75, 93, 219, 231, 298, 320
Carbon 22-23, 231, 320
Coated 231, 298, 320
Stainless ..22-23, 65, 67, 69, 75, 93, 106 121, 231, 268, 298, 311
Tool 75, 298
Strainers 346, 428
Strip, Metallic 51, 231, 234, 311
Studs 245, 325
Switches.....64 A & B, 80-81, 116-120 321, 382, 419, 431
Swivel Joints 239

Index of

PRODUCTS ADVERTISED

In This Issue

•

T

Tables, Dial-Feed 322-323, 438
Tapes 462
Tapes, Insulating (see Insulation)
Testing Machines & Equipment..... 225, 324, 376
Thermostats 259, 306, 411
Timers.....64 A & B, 247, 289, 431, 461
Timing Motors 247, 412, 437
Titanium 302
Tools 240
Tracing Cloth 420
Tracing Paper 275
Transformers 116-120, 254
Transmissions 85, 399
Traps (Steam) 346
Tubing
  Lock-Seam 51
  Plastic 108, 427
  Seamless 33, 75, 223, 434
  Welded....10, 22-23, 101, 121, 223, 341

U

Universal Joints 398

V

Valves
  Air.....1, 212, 262-263, 299, 346, 363, 367, 448
  Hydraulic....63, 85, 212, 299, 337, 343, 346, 358, 386, 440, 444, 448
Vibration Dampers
  Mechanical 405
Vibration Mountings 225, 405
Vibratory Equipment 225, 376

W

Washers.....84, 315, 348, 361, 393, 426
Washers (see Packings)
Welding
  Equipment 398, 425
  Nuts 443
  Supplies 398
Weldments 52-53, 391
Wheels 463
Wire 50, 75, 268
Wire & Cable..... 268
Wire Cloth 84, 86, 268, 416, 465
Wire Forming 440
Wiring Devices 240, 369

Z

Zinc 12
Zinc Coated Strip..... 231

compact
rugged
enclosed
dependable

HAYDON*

APPLIANCE TIMER

A new Haydon Interval Timer with the rugged construction needed for long appliance life . . . at an attractive price. Highest quality throughout. New cantilever contact principle gives crisp break and fast, sliding contact make. Number or type of terminals can be specified. Roller-cam follower minimizes wear and contributes to smooth, easy-turning settings in either direction. Unusual compactness and all-position operation allows freedom in choice of timer location.

If the HAYDON Field Engineer in your area has not shown you this new Series 8028 Interval Timer — write for information.

*Trademark Reg. U.S. Patent Office

HAYDON AT TORRINGTON
HEADQUARTERS FOR TIMING

A SUBSIDIARY OF GENERAL TIME CORPORATION

HAYDON Manufacturing Company, Inc.
3135 ELM STREET, TORRINGTON, CONN.

VIBRATION-DAMPING

SHOCK-ABSORBING

SKID-PROOFING

CUSHIONING

NOISE-KILLING

SCRATCH-PREVENTION

GLAZING STRIP

DUST-PROOFING

Armstrong DK-153 Resilient Tape makes a simple but effective dust seal for delicate instruments.

This resilient cork-and-sponged-rubber material attaches with a pressure-sensitive adhesive that eliminates mechanical fasteners. Just peel off protective backing and press tape into place. It sticks to almost any clean, dry surface.

Strips or die-cut pads of DK-153 are easily designed for any application . . . from skid-proofing telephones to cushioning TV picture tubes. Wherever a springy, non-skid pad or cushion is needed, save money and time with Armstrong DK-153 Tape.

You can order DK-153 in tapes, sheets, rolls, or die-cut shapes, in thicknesses from 1/32 inch to 3/16 inch. For samples, write on your letterhead to Armstrong Cork Company, Industrial Division, 7311 Irvin Street, Lancaster, Pennsylvania. Available for export.

Armstrong DK-153 TAPE

. . . used wherever performance counts

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

Abbott Ball Co. 330
Acme Chain Corp. 258
Acme Rubber Manufacturing Corp. .. 308
Acro Switch Div., Acro Mfg. Co. 419
Acushnet Process Co. 284
Aircraft-Marine Products, Inc. 240
Alemite 63
Allegheny Ludlum Steel Corp. 298
Allen-Bradley Co. ..... 64A & B
Allen Mfg. Co. 87
Allied Research Products, Inc. 296
Allis-Chalmers Mfg. Co. 18-19, 46
Allis Co., Louis 397
Allmetal Screw Products Co., Inc. 70
Aluminum Co. of America..90-91, 112-113 388, 434
American Blower Corp. 380
American Brass Co. 89, 95
American Chain & Cable Co., Inc. 238
American Chemical Paint Co. 282
American Hard Rubber Co. 390
American Nickeloid Co. 234
American Screw Co. 70
American Steel & Wire Div., U. S. Steel Corp. 65, 67, 69
Ampco Metal, Inc. 256
Amplex Mfg. Co., Div. Chrysler Corp. 109
Arens Controls, Inc. 402
Armco Steel Corp. 10
Armstrong Cork Co. 39, 111, 462
Arwood Precision Casting Corp. 336
Associated Spring Corp. 379
Atlantic Screw Works, Inc. 70
Austenal Laboratories, Inc., Microcast Div. 368
Automatic Electric Sales Corp. 210
Automatic Switch Co. 321
Automation-Engineering Corp. 408

Bakelite Co., Union Carbide & Carbon Corp. 24-25, 107, 333
Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 233
Barco Mfg. Co. 314
Barry Controls, Incorporated 225
Bausch and Lomb Optical Co. 422
Bead Chain Co. 250
Bean & Co., Morris 396
Bearing Appliance Co. 418
Beaver Precision Products, Inc. 280
Bird Co., Inc., Richard H. 382
Blake & Johnson Co. 70
Bodine Electric Co. 124, 260-261
Boundbrook Oil-less Bearing Co. 57
Bower Roller Bearing Div., Federal Mogul-Bower Bearing, Inc. 395
Bridgeport Brass Co. 102
Bridgeport Thermostat Div., Robertshaw-Fulton Controls 372
Bristol Co., Socket Screw Div. 414
Brooks & Perkins, Inc. 413
Browning Mfg. Co. 434
Bruning Co., Inc., Charles 275, 313
Brush Electronics Co. 324
Bunting Brass & Bronze Co. 404

Calidyne Co. 376
Cambridge Wire Cloth Co. 416
Carpenter Steel Co. 106
Carpenter Steel Co., Alloy Tube Div. . 121
Carter's Ink Co. 418
Celanese Corp. of America 287
Centralab Div., Globe-Union Inc. 310
Central Foundry Div., General Motors Corp. 20-21
Central Screw Co. 70
Centr-O-Cast & Engineering Co. 255
Century Electric Co. 272-273
Chace Co., W. M. 445
Char-Lynn Co. 444
Chase Brass & Copper Co. 84
Chemical Corp. 300
Chicago Molded Products Corp., Campco Div. 288

INDEX TO ADVERTISERS

Chicago Rawhide Mfg. Co.....2nd Cover
Chicago Screw Co..... 424
Chiksan Co. 239
Chrysler Corp., Industrial Engine Div. 214
Clare & Co., C. P..... 295
Cleveland Cap Screw Co..... 325
Cleveland Pneumatic Tool Co..... 326
Cleveland Worm & Gear Co..... 43
Clifford Mfg. Co..... 279
Cold Metal Products Co..... 231
Columbia-Geneva Steel Div., U. S. Steel Corp. 65, 67, 69
Consolidated Engineering Corp..... 421
Continental Screw Co..... 70
Copperweld Steel Co., Ohio Seamless Tube Div. 223
Cramer Co., Inc., R. W..... 247
Cramer Posture Chair Co., Inc..... 378
Crane Packing Co..... 274
Crown Gear, Sub. of Harrington & Richardson, Inc. 417
Crucible Steel Co. of America..... 93
Cullman Wheel Co..... 447
Cuno Engineering Corp.....252-253
Curtis Universal Joint Co., Inc..... 398
Cutler-Hammer, Inc. 235, 426

Darling Valve & Mfg. Co..... 459
Daystrom Instrument Div., Daystrom, Inc. 387
Detroit Coil Co..... 381
Detroit Die Set Corp..... 270
Dodge Mfg. Corp..... 328
Dormeyer Industries 414
Dow Chemical Co..... 100
Dow Corning Corp.....96A & B
Dudco Div., The New York Airbrake Co. 342
Dudek & Bock Spring Mfg. Co..... 440
DuPont de Nemours & Co., Inc. E. I., Fabrics Div..... 297
DuPont de Nemours & Co., Inc. E. I., Neoprene..... 47
DuPont de Nemours & Co., Inc. E. I., Plastics.....32A & B
Durakool, Inc. 382
Dynamatic Div., Eaton Mfg. Co..... 16

Eagle Lock Co..... 70
Eagle Signal Corp..... 289
Eastern Air Devices, Inc..... 356
Eastman Kodak Co. Industrial Photographic Div. 267
Eastman Mfg. Co..... 265
Elastic Stop Nut Corp. of America... 227
Elco Tool & Screw Corp..... 70
Electric Wheel Co..... 463
Electro Dynamics Div., General Dynamics Corp. 345
Enjay Co., Inc..... 349
Erico Products Co..... 444
Euclid Electric & Mfg. Co..... 442

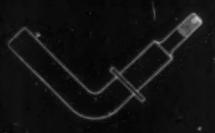
Fairbanks, Morse & Co., Electric Motor Div. 291
Fairchild Aircraft Div., Fairchild Engine & Airplane Corp..... 458
Fairfield Mfg. Co..... 394
Falk Corp. 327
Fasteners, Inc. 245
Faultless Caster Corp..... 383
Federal Bearings Co., Inc..... 286
Federal Mogul Div., Federal-Mogul-Bower Bearing, Inc..... 357
Federal Telephone & Radio Co., Div. of International Telephone & Telegraph Corp. 409
Fenwal, Inc. 306
Ferguson Machine & Tool Co.....322, 323
Firestone Plastics Co., Chemical Sales Div., Div. of Firestone Tire & Rubber Co. 257
Flexonics Corp. 400
Flower Mfg. Co., D. B..... 388
Foote Gear Works, Inc., Brad..... 437
Ford Instrument Co., Div. of Sperry-Rand Corp. 439

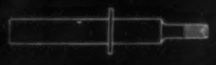
(Continued on Pg. 464)

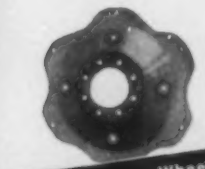
ELECTRIC

Wheels Engineered for the Job

WRITE US FOR RECOMMENDATIONS






Rear Tractor Wheel for Demountable Rim

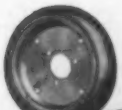
Planter Press Wheel—one piece rim with or without rubber tire

Rear Tractor Wheel Reversible

Pick-up Wheel Crown-face Steel Rim

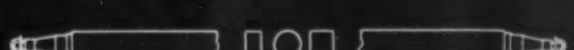
Garden Tractor Wheel Reversible

Combine Wheel Reversible


Press and Gage Wheel Rubber Tire

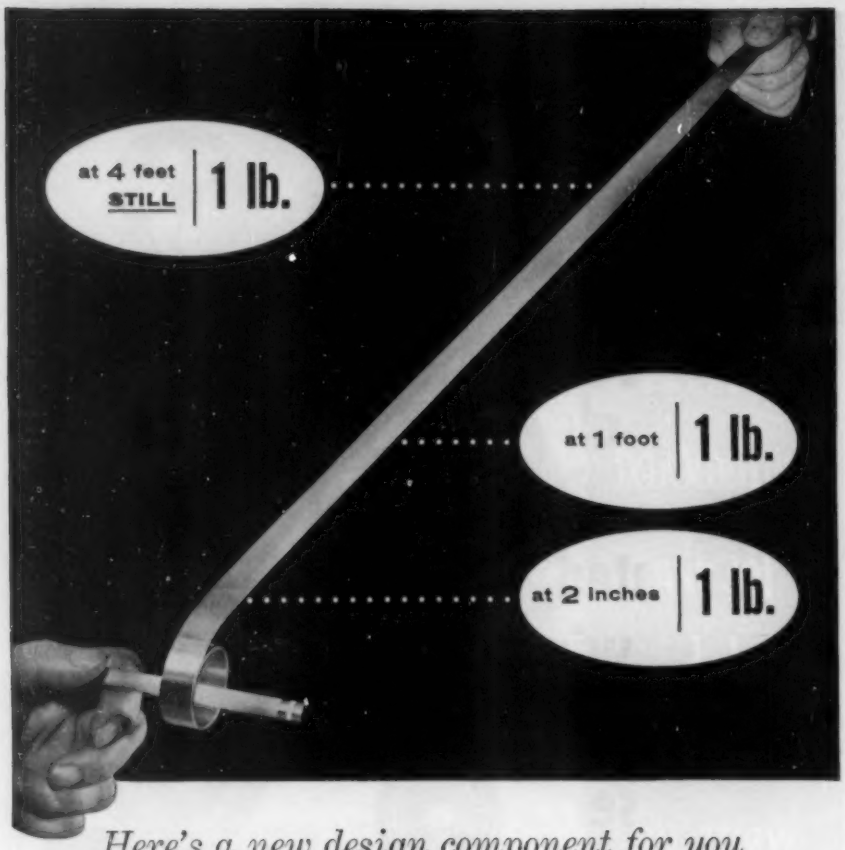
Spreader Wheel

SAE Implement Wheel Reversible



ELECTRIC WHEEL COMPANY

2805 SPRUCE · QUINCY, ILLINOIS



Here's a new design component for you

THE FIRST CONSTANT FORCE SPRING!

Do *you*, too, want to simplify a product design problem — reduce weight, miniaturize, cut cost, *improve* the product, or even create a *new* product?

Can you use a *constant force spring* that's *not only a spring* but also a *motor*, a *counterbalance*, a *clamp*, *clip*, *slot closure*, and anything else *you* might make it?

The Hunter Neg'ator *constant force* spring upsets all previous spring principles. In addition to a zero gradient, negative or slightly positive gradients are also possible with the Neg'ator.

Hundreds of ingenious engineers have already used the Neg'ator spring to obtain—

- Tremendous extensions—over 30 times the original size—with no appreciable force build-up.
- Driving torques with longer duration and *no* heavy wind-up.
- Full force available from the very beginning of the stroke right up to the completion of the return stroke.
- The equivalent of a dead weight (in a range sufficient to counterbalance a mouse or a man) in one handful.
- Many other unusual characteristics.

Are *you* ready to learn more about this remarkable new spring element? We're ready to tell you. Just ask for our new bulletin, "The Hunter Neg'ator Spring". This bulletin describes the Neg'ator force characteristics, and its variety of forms and applications. Also included are many "thought provokers" for applying this promising new mechanical element.

THE HUNTER
neg'ator
constant force spring

HUNTER SPRING COMPANY

Lansdale, Pennsylvania . . . near Philadelphia

SPRINGS • STAMPINGS • TEST APPARATUS

INDEX TO ADVERTISERS

(Continued from Pg. 463)

Formica Co. 339
Fort Wayne Metals, Inc. 268
Frenchtown Porcelain Co. 386
Fulton Sylphon Div., Robertshaw Fulton Controls Co. 236-237
Fusite Corp. 438

Galland-Henning, Nopak Div. 448
Garlock Packing Co. 303
Garrett Co. Inc., George K. 348
Gear Specialties, Inc. 11
General Dynamics Corp., Electro Dynamics Div. 345
General Electric Co., Apparatus Dept. 40-41, 60-62, 116-120
General Electric Co., Chemical Div. (Molded Plastics) 77
General Industries Co. 360
General Plate Div., Metals & Controls Corp. 31
Gering Products, Inc., Extruded Products Div. 427
Gerotor May Corp. 399
Gits Bros. Mfg. Co. 285
Gleason Works 6
Goodrich Co., B. F. 66
Great Lakes Screw Corp. 70
Great Lakes Steel Corp., Div. National Steel Corp. 219
Gries Reproducer Corp. 366
Grip Nut Co. 448

Hannifin Corp. 363
Hansen Mfg. Co., Inc. 412
Harper Co., H. M. 70
Hartford Steel Ball Co. 426
Haydon Co., A. W. 437
Haydon Mfg. Co., Inc. 461
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 32
Heim Co. 42
Helicoid Gage Div., American Chain & Cable Co., Inc. 238
Hilliard Corp. 266
Hoffman Engineering Corp. 434
Hoke, Inc. 386
Holtzer-Cabot Div. of National Pneumatic Co., Inc. 335
Houghton & Co., E. F. 301
Howell Electric Motors Co. 305
Hughes Research & Development Laboratories 449
Hunter Douglas Corp. 359
Hunter Spring Co. 464
Hyatt Bearings Div., General Motors Corp. 99
Hydreco Div., The New York Airbrake Co. 343

Illinois Gear & Machine Co. 251
Imperial Tracing Cloth 420
Instrument Specialties Co., Inc. 435
International Harvester Co. 317
International Nickel Co., Inc. 76, 98
International Packings Corp., Sub. of Graton & Knight Co. 361

Janette Electric Mfg. Co. 54-55
Jeffrey Co., Inc. 370
Johns-Manville Corp. 316
Johnson Bronze Co. 283
Johnson Corp. 438
Johnson Machine Co., Carlyle 68
Jones & Laughlin Steel Corp. 341

Kaiser Aluminum & Chemical Corp. 35-38
Kaydon Engineering Corp. 229
Kearfott Co., Inc. 429
Killan Mfg. Corp. 432
Kraissl Co., Inc. 428

L. O. F. Glass Fibers Co. 457
Lamb Electric Co. 329
Lamson & Sessions Co. 70, 315

INDEX TO ADVERTISERS

Leland, Inc., G. H. 460
Librascope, Inc. 312
Lincoln Electric Co. 398
Linde Air Products Co., Div. of Union Carbide & Carbon Corp. ..304, 433
Linear, Inc. 351
Link Belt Co. 13, 15, 103
Logansport Machine Co., Inc. 344
Lord Mfg. Co. 405
Lukens Steel Co. 320

McGill Mfg. Co., Inc. 221
McLouth Steel Corp. 311
Madison-Kipp Corp. 246
Magline, Inc. 406
Magnesium Co. of America 442
Magnetic Amplifiers, Inc. 254
Mahon Co., R. C. 391
Mallory & Co., Inc., P. R. 4, 78
Manhattan Rubber Co. 104-105
Marquette Metal Products Co. 385
Marsh Instrument Co. 424
Massachusetts Gear & Tool Co. 415
Master Electric Co. ..... 3rd Cover
Matthews & Co., Inc., Jas. H. 424
Maurey Mfg. Corp. 455
Mayline Co. 436
Mead Specialties Co. 438
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 80-81
Midland Steel Products Co. 443
Miniature Precision Bearings, Inc. 468
Minneapolis Honeywell Regulator Co., Industrial Div. 259
Minnesota Mining & Mfg. Co. 64
Moraine Products Div., General Motors Corp. 371
Morse Chain Co. 249
Mosinee Paper Mills Co. 244
Mt. Vernon Die Casting Corp. 110
Mueller Brass Co. 307

National Acme Co. 319
National Lock Co. 70
National Motor Bearing Co., Inc. 71
National Pneumatic Co., Inc., Holtzer-Cabot Motor Div. 335
National Screw & Mfg. Co. 70
National-Standard Co. 86
National Steel Corp. 219
National Tube Div., U. S. Steel Corp. 33, 65, 67, 69
National Vulcanized Fibre Co. 347
Naugatuck Chemical Div. of U. S. Rubber Co. 72-73
Neise, Karl A. 442
Newark Wire Cloth Co. 465
New Departure Div., General Motors Corp. 128
New Hampshire Ball Bearings, Inc. 364
New Jersey Zinc Co. 12
New York Brake Co., The 342-343
Nicholson & Co., W. H. 346
Norgren Co., C. A. 262-263

Ohio Seamless Tube Div. of Copperweld Steel Co. 223
Ohmite Mfg. Co. 277-278

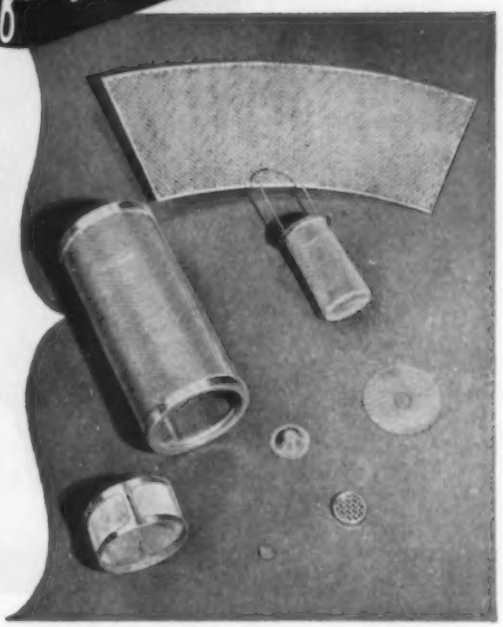
Packard Electric Div., General Motors Corp. 340
Palnut Co. 426
Parker Appliance Co. 365
Parker-Kalon Div., General American Transportation Corp. 58-59, 70
Parker Rust Proof Co. 8
Penn Metal Co., Inc. 354
Perkins Machine & Gear Co. 403
Pesco Products Div., Borg Warner Corp. 401
Pheoll Mfg. Co. 70
Philadelphia Gear Works, Inc. 122
Phoenix Manufacturing Co., Rubber Products Div. 264

(Continued on Pg. 466)

Our Slogan...

NEWARK for ACCURACY

applies also to "fabricated" wire cloth inserts



Our slogan, Newark for Accuracy, has long been known to users of bulk wire mesh cloth, wire space cloth and wire filter cloth. It is now becoming more and more familiar to users of parts fabricated from wire cloth made by a fast-growing division of our company.

These parts, similar to those illustrated, are fabricated or assembled for our customers by skilled workmen in our large department specializing in this work. We are equipped to handle small lots or in production quantities of anything from large jet intake screens to tiny fuel pump strainers.

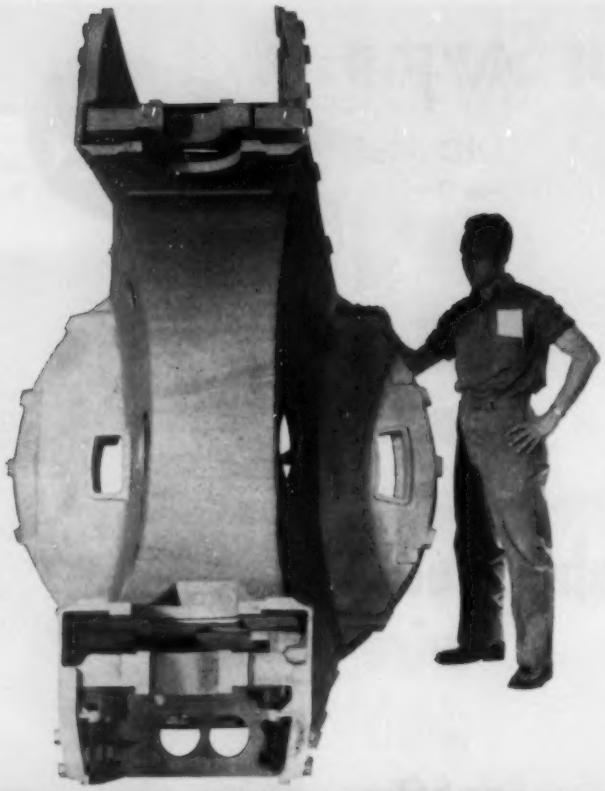
We shall be glad to quote on your requirements; and, if necessary, our experienced engineers stand ready to assist you in the design of the part so as to make the best use of the mesh and to assure the most economical manufacture of the part as a whole.

Remember, since we weave the cloth used, and do all the necessary cutting, fitting, stamping, punching, forming, binding, welding and soldering, there is only one responsibility . . . OUR responsibility . . . to deliver parts that live up to our slogan — Newark for Accuracy.

We can furnish wire cloth woven from all commercially used metals. Sizes range from 4 inches (space cloth) to 400 mesh.

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY



the story of this casting cannot be told

We *can* say that this 620 lb. magnesium yoke is part of a military electronic equipment structure. But no more! It was once seriously doubted that this part *could* be cast. The methods used to solve the problem are the result of Rolle's years of specialization.

The same metallurgical knowledge, casting experience, and foundry facilities which have made this and other equally complex castings possible are available to you. Whether they are commercial or military—in aluminum or magnesium alloys—to be sand or permanent mold cast —you will find Rolle capable of solving your casting problems.

Write now for your copy of a free booklet on Rolle complete foundry service to Rolle Manufacturing Company, 311 Cannon Avenue, Lansdale, Pennsylvania.

fight weight with **ROLLE**

MANUFACTURING COMPANY

311 Cannon Avenue Lansdale, Penna.

INDEX TO ADVERTISERS

(Continued from Pg. 465)

Polymer Corp. of Pennsylvania..... 108
Porcelain Products, Inc..... 402
Potter Brumfield Mfg. Co., Div. American Machine & Foundry Co. 26-27
Power Products Corp..... 436
Pratt & Whitney..... 456
Precision Castings Co., Inc., Sub. of Harrisburg Steel Corp..... 332
Precision Extrusions 441
Precision Rubber Products Corp..... 269
Production Instrument Co..... 413
Progressive Mfg. Co..... 420
Protective Closures Co., Inc..... 402

Racine Hydraulics & Machinery, Inc. 358
Ramsey Corp. 436
Raybestos-Manhattan, Inc.....104-105
Equipment Sales Div.
Manhattan Rubber Div.
Packings Div.
Raybestos Manhattan, Inc., Manhattan Rubber Div. 104-105
Reeves Pulley Co., Div. of Reliance Electric & Engrg. Co...114-115
Reliance Electric & Engineering Co... 355
Rem-Cru Titanium, Inc..... 302
Republic Mfg. Co..... 440
Republic Steel Corp.....22-23
Revere Copper & Brass Inc.....2, 51
Reynolds Metals Co., Parts Div.....52-53
Rhodes Inc., M. H..... 431
Richardson Co. 294
Rivette Lathe & Grinder, Inc..... 299
Robertshaw-Fulton Controls Co., Robertshaw Thermostat Div..... 411
Rochester Products Div., General Motors Corp. 101
Rockford Clutch Div., Borg-Warner Corp. 386
Rockford Screw Products Co..... 70
Rockwood Sprinkler Co. (Ball Valve Div.) 337
Rogers Corp. 290
Rolle Manufacturing Co..... 466
Roper Corp., Geo. D..... 410
Ross Operating Valve Co..... 1

Saginaw Steering Gear Div., General Motors Corp..... 407
Sauereisen Cements Co..... 442
Schundler & Co., Inc., F. E..... 392
Scovill Mfg. Co.....70, 334
Screw Research Association..... 70
Sculp-Metal Co. 423
Segal, Edward 432
Shakeproof Div., Illinois Tool Works. 70
Sigmamotor, Inc. 447
Sier-Bath Gear & Pump Co., Inc., Gear Div. 423
Simmons Fastener Corp..... 74
Solar Aircraft Co..... 309
South Chester Corp., Southco Div.... 56
Southington Hardware Mfg. Co..... 70
Spaulding Fibre Co., Inc..... 375
Spencer Thermostat Div., Metals & Controls Corp..... 30
Square D Co.....48-49
Stacor Equipment Co..... 432
Stalwart Rubber Co..... 417
Standard Pressed Steel Co.....276, 377
Sterling Bolt Co..... 70
Sterling Engineering Div., American Machine & Foundry Co.....26-27
Stewart Warner Corp. (Alemite).... 63
Stewart Die Casting Div., Stewart Warner Corp..... 97
Stokes Machine Co., F. J..... 352
Stronghold Screw Products Inc..... 70
Sylvania Electric Products, Inc., Parts Div. 50, 96

Taylor Fibre Co..... 350
Taylor-Winfield Corp. 425
Tennessee Coal & Iron Div., U. S. Steel Corp.....65, 67, 69
Thermoid Co. 384
Thiokol Chemical Corp..... 281

INDEX TO ADVERTISERS

Thomas Flexible Coupling Co..... 338
Thompson-Bremer & Co., Sub. of American Machine & Foundry Co.. 393
Tickle Engineering Works, Inc., Arthur 414
Timken-Detroit Brake Co., Rockwell Spring & Axle Co..... 374
Timken Roller Bearing Co.....4th Cover
Timken Roller Bearing Co., Steel & Tube Div..... 75
Tinnerman Products Inc..... 126
Tomkins-Johnson Co. 271
Torrington Co. (Needle Bearing).... 88
Torrington Co., Specialties Div..... 34
Transiccil Corp. 293
Turco Products, Inc..... 292

Union Carbide & Carbon Corp., Bakelite Co. 24-25, 107, 333
Haynes Stellite Co..... 32
Linde Air Products Co.....304, 433
United-Carr Fastener Corp..... 369
United Chromium Div., Metal & Thermit Corp. 241
U. S. Electrical Motors, Inc..... 331
U. S. Gasket Co..... 318
U. S. Graphite Co.....44-45
U. S. Rubber Co..... 14
U. S. Rubber Co., Footwear Div..... 94
U. S. Rubber Co., Naugatuck Chemical Div. 72-73
U. S. Steel Corp.....65, 67, 69
U. S. Steel Export Co.....65, 67, 69
U. S. Steel Supply Div., U. S. Steel Corp. 65, 67, 69
Universal Clay Products Co..... 444
Universal Oil Seal..... 428
Universal Screw Co..... 70

Veeder-Root, Inc. 17
Versa Products Co., Inc..... 212
Vickers, Inc., Div. of Sperry-Rand Corp. 85
Viking Pump Co..... 415
Virginia Gear & Machine Corp..... 122
Vulcan Electric Co..... 420

Wagner Electric Corp..... 248
Waldes-Kohinoor, Inc. 79
Wales-Beech Corp. 70
Watlow Electric Mfg. Co..... 250
Waukesha Foundry Co., Foundry Div. 389
Weckesser Co. 423
Weldon Tool Co..... 467
Western Gear Works..... 373
Westinghouse Electric Corp. 28-29, 82-83, 92
West Point Manufacturing Co..... 418
Wiegand Co., Edwin L. Ind. Div..... 362
Winsmith, Inc. 353
Wisconsin Motor Corp..... 430
Worthington Corp., Multi-V Drive 242-243
Worthington Corp., Pump & Compressors Div. 367

PROFESSIONAL SERVICES..... 451

Classified Advertising
F. J. Eberle, Ass't. Mgr.

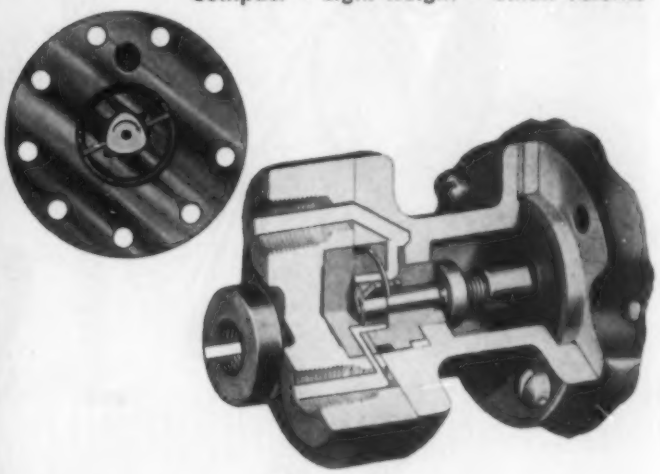
EMPLOYMENT OPPORTUNITIES..451-454
SPECIAL SERVICES
Contract Work..... 451
BUSINESS OPPORTUNITIES
Wanted 451

Index to Advertisers begins on P 462
Products Index begins on P 455

WELDON
FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.

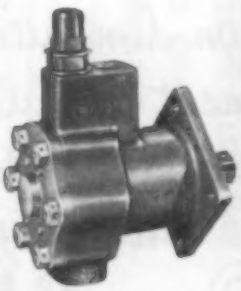
Compact • Light Weight • Small Volume



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.

STYLE A—Single inlet double outlet type aircraft pump



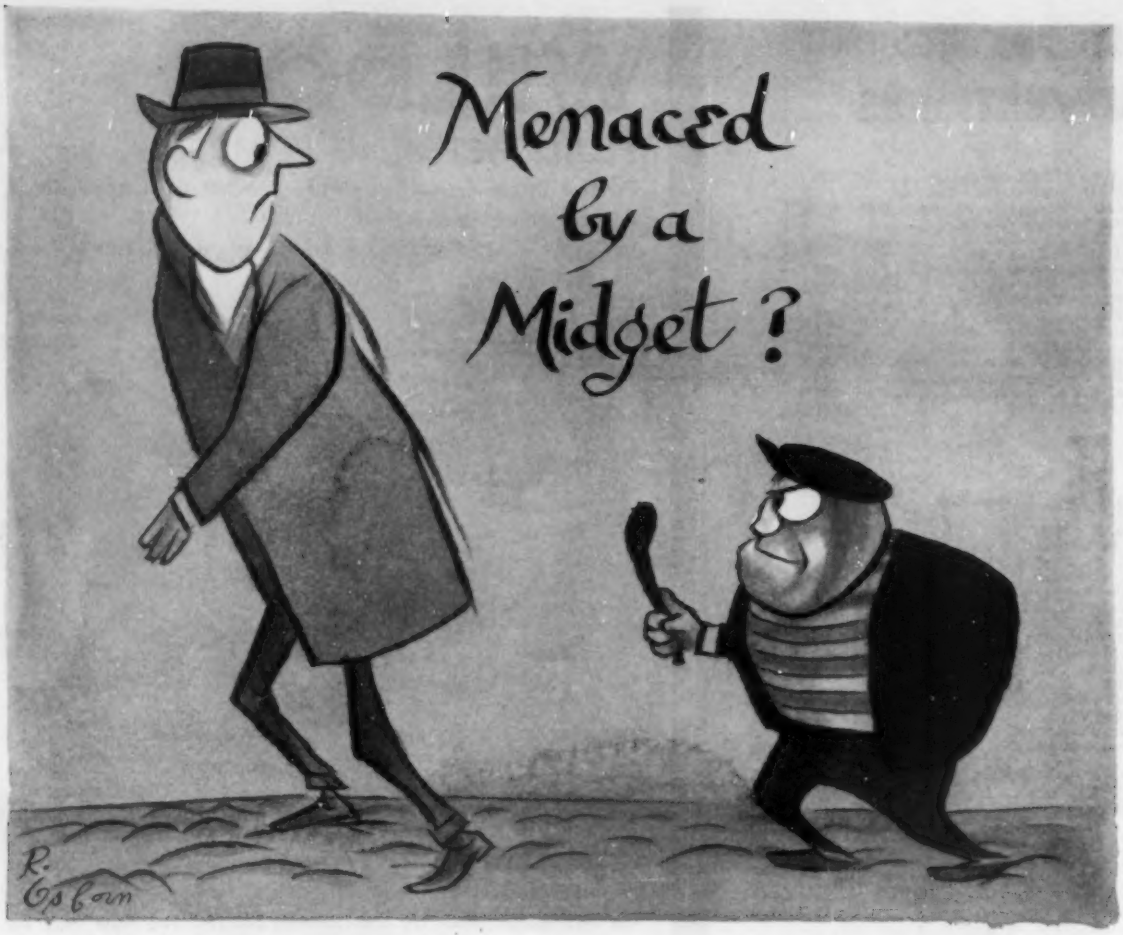
STYLE F—Engine driven fuel pump

STYLE C—Industrial pump

Send for Weldon Manual and Catalog with detailed specifications and installation drawings.

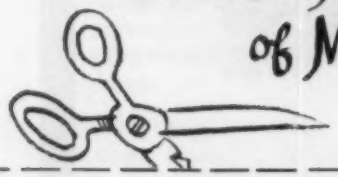
THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO



Being hounded by a problem in miniaturization? Are you harassed by a toughie in the increasingly critical field of design diminution, weight and size reduction, power and component capsulation? If you are, simply stop in at the nearest scissors store. Get a pair of pinking shears and cut out this coupon. It will get you the complete catalog of MPB's ✳ such as these

BALL BEARINGS ACTUAL SIZE



CUT OUT AND MAIL THIS COUPON TODAY

Miniature Precision Bearings, Inc., 4 Precision Park, Keene, N. H.

YES! Send me your complete new MPB CATALOG

name _____ title _____ company _____

street _____ city _____ zone _____ state _____

✳ MINIATURE PRECISION BEARINGS, INC., KEENE, N. H.

NEW 3-POINT EASY-TO-USE

READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalog and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key number in the space indicated. Bulletins are described on pages 348 to 376.

To get more data about new Components, Materials and Parts fully described on pages 216 to 343, just circle the oppropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Bottom; R—Right; L—Left; TL—Top Left; BL—Bottom left; TR—Top right; BR—Bottom right.

For specialized data . . . prices, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space alloted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 11-55

NEW PRODUCTS... Description of these new engineering materials appear on pages 216 to 343. Circle key number for more data

1—Cleanable Micronic Filter
2—Motor-Driven Time Delay Relay
3—Phase Converter
4—Miniature Screws
5—Drafting Board Lamp
6—Vinyl-Coated Embossed Steel
7—Filter for Hydraulic Systems
8—Lubricator for Small Machines
9—Heat-Expanding Gasket
10—Mastic Washers and Gaskets
11—Ball Bearings to ¼ In. Shaft Dia.
12—Gear Box—Ratios 4:1 to 12,000:1
13—Sub-Miniature Speed Reducer
14—Variable Speed Pulley
15—Hammer-Type Four Lug Nut Union
16—Worms and Gears
17—Oil-Actuated Clutches
18—Miniature Clutches and Brakes
19—Aluminum-Rubber Shock Mountings
20—Miter and Bevel Gears
21—All-Vinyl Hand Grips
22—Self-Locking Miniature Nuts
23—Quarter-Turn Fastener
24—For Overvoltage Protection
25—Lock-Type Electrical Receptacles
26—Preset Electronic Counter
27—Batch Counters
28—Flexible Printed Circuit Cables
29—Elapsed Time Indicator
30—Interval Timing Switch
31—Aluminum-Housed Footswitch
32—Miniature, Rotary, Switch
33—Toggle Switch Manual Starters
34—Centrifugal Switches
35—Servo for 150 C
36—Indicating Pushbuttons
37—Lightweight Servo Motors
38—Shaded Pole Motor
39—General Purpose Open-Type Motor
40—Minature High Speed Solenoid
41—Self-Governed D-c Motor
42—Totally Enclosed Fhp Motor
43—Brake Motor
44—Germanium Rectifiers
45—Frequency Changer 60 to 420 Cps
46—Transistorized Power Supply
47—Power Supply for Ultrasonics
48—High-Torque Magnetic Brake
49—Voltage-Frequency Control
50—Auxiliary Power Supply
51—Power Supply for Use With 28 V, Dc
52—Force-Balance Instrument
53—One-Position Weight Cell
54—Miniature Proximity Generator
55—Shaft-Position Converter
56—Voltage-To-Digits Converter
57—Binary Coded Digital Converter
58—Sub-Miniature Potentiometers
59—Intermediate Size Potentiometers
60—Stepless Temperature Control
61—Magnetic Servo Amplifier
62—Magnetic Servo Amplifiers
63—Controls Process Temperature
64—Moving Coil Instruments
65—Panel Meter With 6 x 2½ In. Face
66—Thermometer With Reading Disks
67—Digital Ohmmeter
68—Rectangular Panel Instruments
69—Tubular Paper Capacitors
70—Capacitors For High Temperature

PRINT or TYPE your address on other side before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	24-5	26-7	28-9	30	31	32	32a-b	33	34	35-8	39	40-1
42	43	44-5	46	47	48-9	50	51	52-3	54-5	56	57	58-9	60
61-2	63	64	64a-b	65	66	67	68	69	70	71	72-3	74	75
76	77	78	79	80-1	82-3	84	85	86	87	88	89	90-1	92
93	94	95	96	96a-b	97	98	99	100	101	102	103	104	L105
R105	106	107	108	109	110	111	112-3	114-5	116-7	118-9	120	121	122
124	126	128	210	212	214	219	221	223	225	227	229	231	233
234	235	236-7	238	239	240	241	242-3	244	245	246	247	248	249
TL250	BL250	251	252-3	254	255	256	257	258	259	260-1	262	263	264
265	266	267	268	269	270	271	272-3	274	275	276	277-8	279	L280
R280	281	282	283	284	285	286	287	288	289	290	291	292	293
294	295	296	297	298	299	300	301	302	303	304	305	306	307
308	309	310	311	312	313	314	315	316	317	318	319	320	321
322	323	324	325	326	327	328	329	330	331	332	333	334	335
336	337	338	339	340	341	342	343	344	345	346	347	348	349
350	351	352	353	354	355	356	357	358	360	361	362	363	364
365	366	367	368	369	370	371	372	373	374	375	376	377	378
379	380	381	TL382	BL382	383	384	385	L386	TR386	BR386	387	L388	R388
389	390	391	392	393	394	395	396	397	L398	R398	399	400	401
L402	TR402	BR402	403	404	405	406	407	408	409	410	411	412	L413
R413	L414	TR414	BR414	TR415	BR415	416	L417	R417	L418	TR418	BR418	419	L420
TR420	BR420	421	422	TL423	BL423	R423	L424	TR424	BR424	425	L426	TR426	BR426
427	L428	R428	429	430	431	T432	BL432	BR432	433	L434	TR434	BR434	435
L436	TR436	BR436	TR437	BR437	L438	TR438	BR438	439	T440	B440	441	L442	TR442
CR442	BR442	443	T444	BL444	BR444	445	TR447	BR447	T448	BL448	455	457	459
460	461	462	463	464	465	466	467	468	C3	C4			

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107					

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

108	109	110	111	112	113	114	115	116	117	118	119	120	121
122	123	124	125	126	127	128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143	144	145	146	147	148	149
150	151	152	153	154	155	156	157	158	159	160	161	162	163
164	165	166	167										

Card expires January 1

CIRCLE THESE KEY NUMBERS FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS FOR YOUR COPIES OF.....

USE THIS SPACE TO INDICATE REQUIRED.....

71—Miniature Capacitors
72—Flat Capacitors
73—Spring-Actuated Slip Sockets
74—Plug-In Tubular Capacitors
75—Resistors for Printed Circuits
76—Plastic Film Capacitors
77—Card-Type Precision Resistor
78—Power-Operated Valve
79—General Purpose Solenoid Valve
80—Low Leakage Sequence Valves
81—Hydraulic Pumps
82—Cushioned Air Motor
83—Fittings For Polyethylene Pipe
84—PVC Fittings and Tubing
85—Detachable Valve Coupling
86—Swivel Joint
87—Coupler for Liquid Gas Transfer
88—High Pressure Hose and Couplings
89—Liquid Level Control
90—Fluid Transfers
91—Float Level Indicator
92—Stainless Steel Pressure Snubber
93—Compressed Air Line Filter
94—Moisture Discharge
95—Eliminates Noise-Shock
96—Leaded, Free Machining Steel Plate
97—Aluminum Foil Tape
98—Fluxless Aluminum Solder
99—Molded Rubber Parts
100—Plating Method for Springs
101—Standard Drawing Details
102—Model of Constant-Force Spring
103—Portable Test Generator
104—Portable Photocopier
105—Transistor Power Supply
106—Micro Storage Containers
107—Filtered D-c Power Supply
108—Cold-Drawn Steels

NEW BULLETINS . . . listed below are described on pages 348 to 376. Circle key number for your copy.

109—Rotating Mechnical Seals
110—Plastics Extrusion and Molding
111—Rotary Pumps
112—Elapsed Time Indicator
113—Ferrous Metallurgy
114—Adjustable Speed Drive
115—Mica Insulation
116—Forgings, Drafting Standard
117—Ceramic Magnets
118—Boron Carbon Resistors
119—High Voltage Resistors
120—Wire-Wound Resistors
121—Vacuum-Melted Metals and Alloys
122—Miniature Pressure Transducers
123—Right-Angle Speed Reducers
124—Magnetic Pulleys
125—Variable Speed Transmission
126—Angular Contact Bearings
127—Graphite Pipe, Fittings
128—Sintered Metallic Oxides
129—Springs
130—Solenoid Valves
131—Drafting Room Furniture
132—Relays
133—Resistors
134—Titanium
135—Literature Index
136—Resistors
137—Flexible Metal Hose
138—Heating Elements
139—Pressure Gages
140—Crystal Diodes
141—Needle Rollers
142—A-c Potentiometer
143—Tube Fittings

PRINT or TYPE your address on other side before mailing

PRODUCTS ADVERTISED

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	24-5	26-7	28-9	30	31	32	32a-b	33	34	35-8	39	40-1
42	43	44-5	46	47	48-9	50	51	52-3	54-5	56	57	58-9	60
61-2	63	64	64a-b	65	66	67	68	69	70	71	72-3	74	75
76	77	78	79	80-1	82-3	84	85	86	87	88	89	90-1	92
93	94	95	96	96a-b	97	98	99	100	101	102	103	104	L105
R105	106	107	108	109	110	111	112-3	114-5	116-7	118-9	120	121	122
124	126	128	210	212	214	219	221	223	225	227	229	231	233
234	235	236-7	238	239	240	241	242-3	244	245	246	247	248	249
TL250	BL250	251	252-3	254	255	256	257	258	259	260-1	262	263	264
265	266	267	268	269	270	271	272-3	274	275	276	277-8	279	L280
R280	281	282	283	284	285	286	287	288	289	290	291	292	293
294	295	296	297	298	299	300	301	302	303	304	305	306	307
308	309	310	311	312	313	314	315	316	317	318	319	320	321
322	323	324	325	326	327	328	329	330	331	332	333	334	335
336	337	338	339	340	341	342	343	344	345	346	347	348	349
350	351	352	353	354	355	356	357	358	360	361	362	363	364
365	366	367	368	369	370	371	372	373	374	375	376	377	378
379	380	381	TL382	BL382	383	384	385	L386	TR386	BR386	387	L388	R388
389	390	391	392	393	394	395	396	397	L398	R398	399	400	401
L402	TR402	BR402	403	404	405	406	407	408	409	410	411	412	L413
R413	L414	TR414	BR414	TR415	BR415	416	L417	R417	L418	TR418	BR418	419	L420
TR420	BR420	421	422	TL423	BL423	R423	L424	TR424	BR424	425	L426	TR426	BR426
427	L428	R428	429	430	431	T432	BL432	BR432	433	L434	TR434	BR434	435
L436	TR436	BR436	TR437	BR437	L438	TR438	BR438	439	T440	B440	441	L442	TR442
CR442	BR442	443	T444	BL444	BR444	445	TR447	BR447	T448	BL448	455	457	459
460	461	462	463	464	465	466	467	468	C3	C4			

NEW PRODUCTS . . .

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101	102	103	104	105	106	107					

NEW BULLETINS . . .

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

108	109	110	111	112	113	114	115	116	117	118	119	120	121
122	123	124	125	126	127	128	129	130	131	132	133	134	135
136	137	138	139	140	141	142	143	144	145	146	147	148	149
150	151	152	153	154	155	156	157	158	159	160	161	162	163
164	165	166	167										

SPECIFIC DATA . . .

Card expires January 1

144—Servo Amplifier
145—Tape Resistors
146—V-Belt Drives
147—Wheel Bearings
148—Rubber-Phenolics
149—Rotary Gear Pump
150—Surface Chromium Alloying
151—Three-Dimensional Cams
152—Electric Clutch
153—Springs
154—Capacitors
155—Vibration Mountings
156—Electrical Tachometers
157—Electrical Relays
158—Electronic Relay
159—Capacitors
160—Pneumatic Equipment
161—Threaded Bushings
162—Porcelain and Stoneware
163—Hydraulic and Air Components
164—Power Transmissions
165—Electronic Controls
166—Investment Casting
167—Flexible Metal Hose

USE THIS SERVICE

. . . . to get your copies of new catalogs and Bulletins

. . . . for information on New Products listed in this issue

. . . . for more information about products advertised in this issue

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

-4¢ POSTAGE WILL BE PAID BY-

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name_____

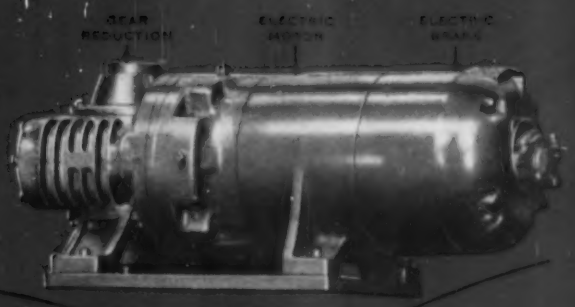
Position_____

Company_____

Address_____

City & State_____ 11-55

Requests for information made through *Product Engineering* Reader's Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

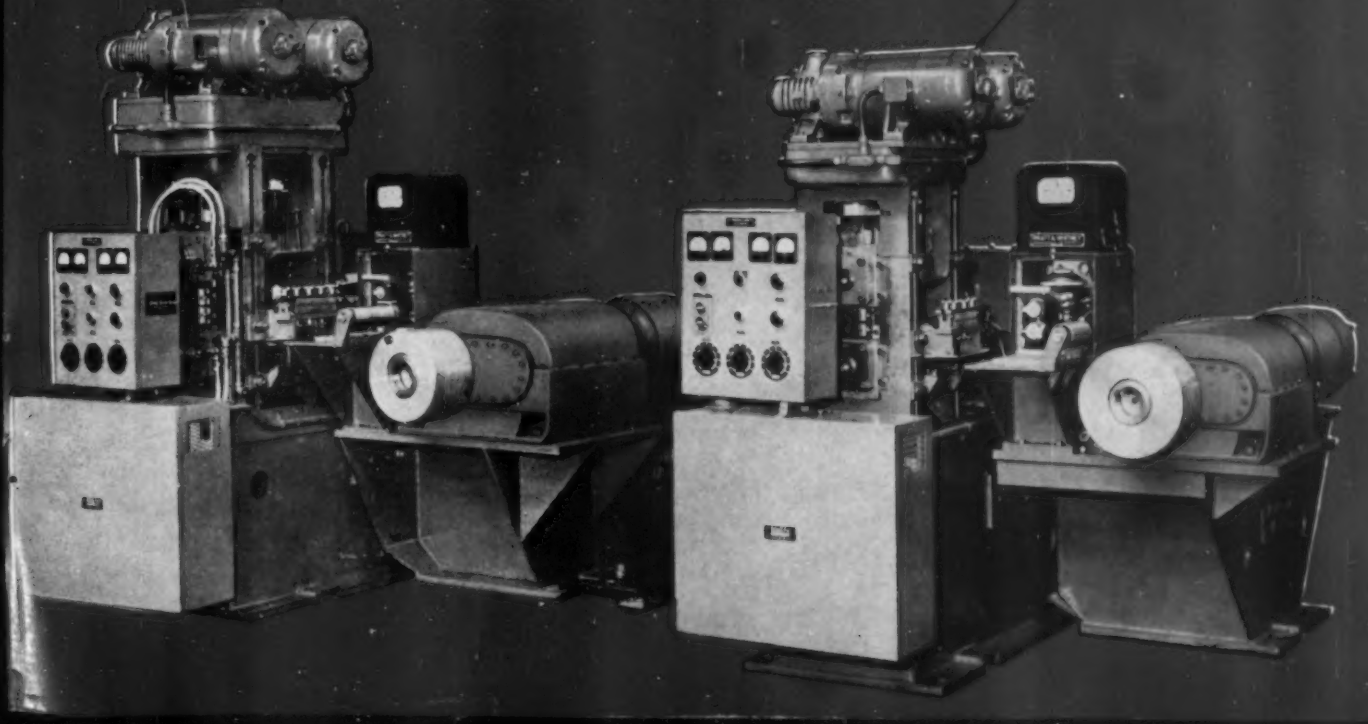


See how easily the standard electric motor, standard gear reduction, standard electric brake combine into a drive that gives the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features . . . all in one compact unit. Nowhere else will you find power units that are so flexible, so easily adaptable, and in such a wide range of types and ratings.

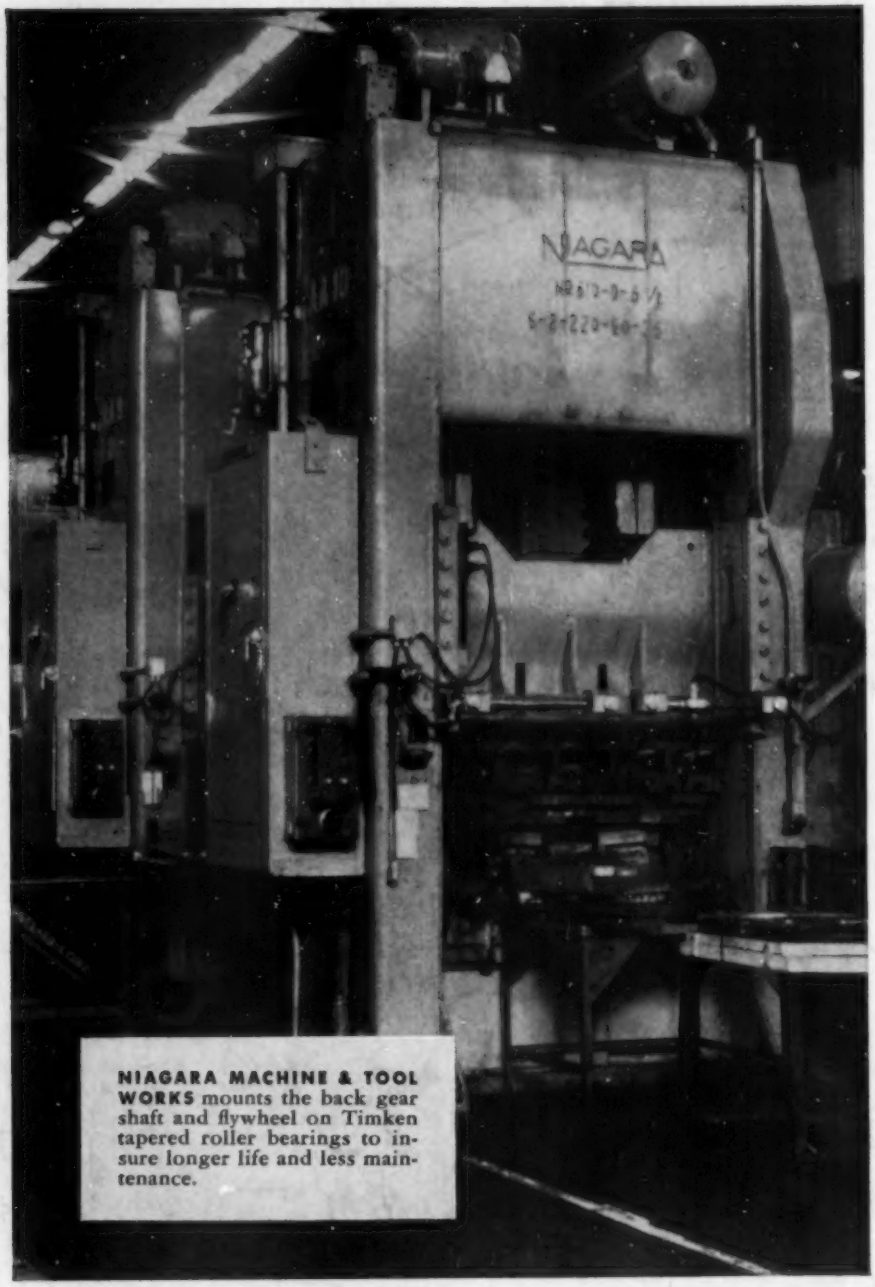
Master power drives are available in thousands and thousands of ratings (⅛ to 400 HP) . . . in open, enclosed, splash proof, fan cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 430 to 1 ratio . . . with electric brakes . . . with fluid-drive . . . with mechanical or electronic variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best power drive for you.

standard units easily combine into special purpose drives

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO



How TIMKEN® bearings cut maintenance on auto body stamping presses



NIAGARA MACHINE & TOOL WORKS mounts the back gear shaft and flywheel on Timken tapered roller bearings to insure longer life and less maintenance.

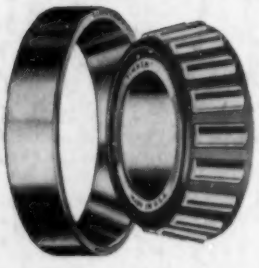
MAINTENANCE and downtime are low in the stamping department of one large automotive manufacturer. One reason: 30 new-design Niagara double crank presses have the back gear shaft and flywheel on Timken® tapered roller bearings.

Every time the press stamps a part, the bearings on the back gear shaft take the heavy shock load. Timken bearings take these loads with ease because rollers and races are case-hardened. This gives them a hard, wear-resistant surface over a tough, shock-resistant core. Full line contact between rollers and races of Timken bearings gives them extra load carrying capacity to hold shafts in line. There's minimum maintenance, less downtime.

Timken bearings help gears last longer, too. They insure accurate gear mesh because Timken bearings' tapered construction lets them take both radial and thrust loads in any combination. The taper prevents lateral movement of the shaft. Flywheels do not become worn or loose, crankshaft wear is prevented.

Be sure to specify Timken bearings for all the machinery you build or buy. They give longer life with less friction. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, O. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

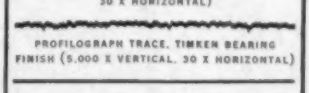


TIMKEN

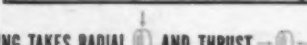
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)



PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)



OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬭ AND THRUST →⬭← LOADS OR ANY COMBINATION →✳←